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Coláiste na hOllscoile Corcaigh

A study of consumers' attitudes towards food products containing protein derived from beef offal

Thesis presented by

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Declaration of Originality

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List of Abbreviations

ABC	Affect, Behaviour and Cognition
ABPs	Animal By-Products
ACE	Angiotensin-Converting-Enzyme
IFA	Irish Farmers' Association
AMP	Affect Misattribution Task
ANOVA	Analysis of variance
BSE	Bovine Spongiform encephalopathy
CS	Conditional Stimulus
DAFM	Department of Agriculture, Food and the Marine
DPMs	Dual-Processing Models
EC	Evaluative Conditioning
EV	Expectancy-Value
FAO	Food Agricultural Organization
FCPM	Food Choice Process Model
FSA	Food Standards Agency
HSM	Heuristic Systematic Model
ISP	Isoelectric Precipitation
TPB	Theory of Planned Behaviour
TRA	Theory of Reasoned Action
US	Unconditioned Stimulus

Abstract

A considerable body of research work has identified that beef fifth quarter contains high amounts of protein which can be extracted, leading to the opportunities for the development of new applications in the food industry. However, many parts of beef fifth quarter are currently underutilised for this purpose due to current practices within the beef sector. Besides the significant research investment within the area of beef fifth quarter protein valorisation, a challenge may lie in consumers' evaluations of food products containing protein extracted from beef fifth quarter. A nationally representative survey (n=953) was undertaken to investigate Irish consumers' attitudes towards hypothetical food products containing protein derived from beef offal sources. Based on an experimental design from the outset, this study explored what attitude processes (intuitive and/or deliberate) dominate attitude formation towards food products containing protein derived from beef offal and if resulting attitudes are influenced by affect and/or cognition. Moreover, the moderation effects of product familiarity and ambivalence on attitude formation were examined. Data analysis revealed that affective inferences played a more significant role in consumers' expressed attitudes. However, consumers were also found to draw on cognitive reasoning to form their attitudes. Deliberate evaluation was found to be a better predictor of consumers' attitudes than intuitive evaluation. Information provision about beef offal extracted protein, and product familiarity, were found to be critical factors in consumers' attitude formation processes and attitude outcome (i.e. affective and/or cognitive) towards food products containing protein derived from beef offal sources.

1 Introduction

1.1 Introduction

The agri-food sector is Ireland's most important indigenous industry (Department of Agriculture, Food and the Marine (DAFM), 2018). The value of goods output by the agri-food sector was €8 billion in 2017 (DAFM, 2018). Beef is one of the major subsectors accounting for over a third of total primary agricultural output in 2017 (Hennessy et al., 2018). Besides producing meat, the sector is characterised by the production of high levels of waste, with Enterprise Ireland (2008) estimating that approximately 263 kg of "waste" is generated per beef animal processed. This "waste" contains non-meat parts left over during the slaughtering, stripping and processing of the animal carcass which include parts of the fifth quarter (e.g. bones, tendons, skin, internal organs and blood).

A considerable research body has highlighted that beef fifth quarter contains high amounts of protein which can be extracted, leading to the development of new applications in the food sector (e.g. Mullen et al., 2017, Mora et al., 2014, Lafarga and Hayes, 2014). The extensive review of scientific work on potential applications of beef fifth quarter protein for food product development, presented in the next chapter, indicates the considerable scientific progress made on this area.

The development of food products containing beef fifth quarter protein, which as mentioned earlier is strongly supported by science and technology advances, derives from two important drivers: satisfying the increasing global demand for protein and reducing the environmental impact of beef production. With regard to the first driver, concerns have been raised that current food production would not suffice to keep up with the growing global population, which requires more food, and particular protein, due to changes in consumption patterns (Huis et al., 2014, Verkerk et al., 2007). Projected demand for protein is expected to double by 2050 (Westhoek, 2011) resulting in search for new or alternative protein sources (Verkerk et al., 2007). With regard to the second driver, i.e. fifth quarter potential contribution to mitigate the environmental impact of beef sector, EBLEX reported that better use of beef fifth quarter in the UK could reduce the carbon footprint of beef sector by approximately 25% (EBLEX, 2014). Currently, significant volumes of beef fifth quarter are used in lower value applications or sent to incineration resulting in negative implication for

the environment and production costs (Selmane et al., 2008). Thus, valorisation of available and underutilised beef fifth quarter protein drives from food security, environmental and economic reasons.

Despite the significant research investment within the area of beef fifth quarter better utilisation, the examination of consumers' attitudes towards food products containing protein derived from beef offal has received little attention. This study addresses this gap by using an online questionnaire, to investigate Irish consumers' attitudes towards hypothetical food products containing protein extracted from beef offal sources. Extensive piloting was undertaken prior to the online survey in order to ensure the suitability and validity of the data collection instruments and of study manipulations.

1.2 Research objectives and questions

The aim of this research was to explore Irish consumers' attitudes on incorporating protein extracted from beef offal into food products and to investigate attitude formation processes. Heavily based on an experimental design from the outset, this work also aimed to provide insight into how information about protein extracted from beef offal, and product familiarity, influence attitudes and attitude formation towards the food products containing protein derived from beef offal. The moderation effects of familiarity and ambivalence on attitudes formation were examined through specific hypotheses.

The core research question of this study was the following:
What attitude processes dominate attitude formation towards food products containing protein extracted from beef offal and are the resulting attitudes more affective or cognitive in nature?

Additional research questions, deriving from this core question, were as follows:

- *Are attitudes towards food products containing protein extracted from beef offal influenced by affect and/or cognition?*

- *In terms of underlying processes, to what extent can attitudes towards food products containing protein extracted from beef offal be predicted by intuitive and/or deliberate evaluations?*
- *Does information influence attitudes towards food products containing protein extracted from beef offal?*
- *Does product familiarity influence attitudes towards food products containing protein extracted from beef offal*

1.3 Thesis design

This thesis is divided in seven Chapters. Chapter 1 introduces the research and the motivation for this study. The specific objectives and research questions are also introduced. Chapter 2 provides a contextual background for the overall research through an extensive literature review of recent scientific research in valorisation of fifth quarter protein and identifies the opportunities for utilising protein extracted from offal in food products. Chapters 3 and 4 of this thesis comprise of a literature review. Chapter 3 explores the critical factors that affect food choices and preferences and highlights the role of attitudes in food behaviour. Following this, Chapter 4 reviews social and cognitive psychology theories, to explore what attitudes are and how they arise in order to better understand consumers' evaluations from the perspective of attitude formation and information processing. Chapter 5 presents the research design and methodology applied to address the research question and objectives of the study. It describes the research activities undertaken and provides a description and justification of the quantitative approach used. Chapter 6 presents the results that emerged from the consumer survey. Chapter 7 discusses the findings and relates them to the research questions and to previously conducted related research. Within this chapter, conclusions and recommendations are drawn and limitations of the study are outlined.

2 Opportunities in for adding value to beef fifth quarter

2.1 Introduction

The purpose of this chapter is to contextualise this research in terms of the opportunities to add value to beef fifth quarter components. The chapter starts with an introduction to food waste and food loss and the economic, food security and sustainability impacts of these. Following this, the potential to add value to beef fifth quarter as a strategy to reduce waste is outlined. A detailed description of beef fifth quarter categories and current uses is presented. Opportunities for using beef fifth quarter extracted protein in food products are then presented in detail. Technical and consumer challenges associated with the incorporation of protein extracted from beef fifth quarter into food products are outlined before the conclusions are drawn.

2.2 Food waste and food loss

The Food Agricultural Organization (FAO) refers to food waste as "*…the discarding or alternative (non-food) use of food that is safe and nutritious for human consumption*" and to food loss as "*any food that is lost in the supply chain between the producer and the market. This may be the result of pre-harvest problems, such as pest infestations, or problems in harvesting, handling, storage, packing or transportation. Some of the underlying causes of food loss include the inadequacy of infrastructure, markets, price mechanisms or even the lack of legal frameworks*" (source: http://www.fao.org/food-loss-and-food-waste/en/)

FAO estimates annually food waste and loss across the food supply chain at 1.3 billion tonnes, equalling to one third of global food production (FAO, 2013). Food waste[1] occurs all over the food supply chain, from primary agriculture to end household consumption (FAO, 2011). Technological, economic and societal aspects influence the amount of waste produced at each stage (Otles et al., 2015) and depending on the country, food waste happens at different stages of the food supply chain. In developing countries, food waste (40% of food produced) tend to occur mainly upstream at early stages of the food value chain and can be traced back to

[1] "Food waste" will be used for the rest of the thesis to refer to both food waste and food loss. Researchers and reports frequently use the term "food waste" to refer to the waste arising through the entire supply chain (Foley et al., 2011). There is no official European framework on how to classify and define food waste which contributes to these uncertainties (Stenmarck et al., 2016). This study is not concerned with the strict definitions of food waste/loss.

financial, managerial and technical constraints in harvesting techniques as well as post-harvest handling and storage. In developed countries, food waste (40% of food produced)[2] occurs mostly downstream at the production, processing and consumption phases (Parfitt et al., 2010).

Food waste has a number of interrelated implications in terms of environmental, economic and food security costs (Bond et al., 2013; FAO, 2013). From an environmental perspective, food waste represents a huge pressure on natural capital in terms of natural resources consumption (e.g. energy, water, and land usage), environmental pollution, and biodiversity loss (Stenmarck et al., 2016). Also, food waste contributes indirectly in greenhouse gas (GHG) emissions via the embedded emissions in the production of the wasted food (Vermeulen et al., 2012). In terms of economic costs, the global annual cost of food waste is estimated at roughly € 603 billion in industrialized countries and € 276 billion in developing countries (FAO, 2011). This economic burden leads to higher food prices for consumers (FAO, 2013). From a food security perspective, higher food prices can lead to poor populations which are vulnerable to hunger and malnutrition, being able to afford less food (Gustavsson, 2011). FAO estimated that in 2017 approximately 821 million people were globally undernourished (i.e. around one person out of every nine in the world (FAO, 2018). Rising food prices and food demand[3] stress the importance of reducing food waste and making food available for those in need.

2.3 Food waste at processing level

The most recent estimates of European food waste levels reveal that Households and Food Processing are the sectors contributing the most to European food waste (53% and 19% of EU food waste respectively)[4] (Stenmarck et al., 2016). Galanakis (2012)

[2] "*Surprisingly, the proportion of food not consumed within developing and developed nations is similar; albeit through very different channels*" (Bond et al., 2013 p.4)

[3] Detailed work by Valin et al., (2014) which examines food demand under the influences of population growth, economic wealth distribution and dietary change, estimates a food demand increase of 59–98% between 2005 and 2050.

[4] Primary production, Wholesale and retail, and Food service summed together accounting for 21 % of EU food waste.

focusing on food processing waste describes it as "*residues of high organic load which are usually derived during raw material processing to foodstuff and result in liquid or solid form … and are removed from the production process as undesirable materials*…" (p.68). Waste production surveys in the global food supply chain have identified that a large proportion of the waste in food and drink processing originate from meat, fresh fruits and vegetables, and beverage sectors (Parfitt et al., 2010). However, some of these "waste materials" hold the potential to be re-utilised inside the food chain and for that reason the term "by-products" is commonly used in the food industry and the scientific community (Galanakis, 2012, Otles et al., 2015, Jayathilakan et al., 2012). For example, phenols and carotenoids from fruit by-products can be used as natural food and beverage preservatives (Oreopoulou and Tzia, 2007), while whey, a by-product of cheese processing, has been valorised in nutritional supplements and soft drinks (Madureira et al., 2010, Jayathilakan et al., 2012).

The majority of by-products in the meat industry are produced during slaughtering and processing of meat[5], generating by-products up to 40-50% of the total weight of the animals slaughtered (Cavaleiro et al., 2013). This consists of parts left over from the slaughtering, stripping and processing of the animal carcass, which include parts of the fifth quarter (e.g. bones, tendons, skin, internal organs and blood) (Jayathilakan et al., 2012). However, there is a growing scientific awareness that these parts contain significant amounts of nutritious and functional components when treated and processed correctly (Lynch et al., 2017, Mullen et al., 2017, Toldrá et al., 2012, Baiano, 2014).

Valorisation of beef fifth quarter has particular relevance for the Irish beef sector, which is one of the major subjectors whinin agri-food sector (Hennessy et al., 2018). In 2017, Ireland's Gross Agricultural Output was valued at €8 billion, with the beef sector accounting for over a third of its value (Hennessy et al., 2018). Eurostat data show that in 2018, approximately 1.9 million heads of bovine were slaughtered at Irish beef slaughterhouses. At the same time, the beef sector is characterised by a high level of waste, which has a substantial impact on economy and environment

[5] Wholesalers, retailers and renderers also produce by-products.

(Enterprise Ireland, 2008). Many parts of beef fifth quarter are currently underutilised due to current practices within the industry.

Food Wise 2025[6] highlights that an increase in food production cannot be considered in isolation from its environmental impact. To address this, the meat industry should be focused on managing, environmentally, the natural resources while increasing production (Food Wise report, 2015). Improving the environmental impact and enhancing the economic performance of the Irish meat industry could be achieved through the better utilisation of fifth quarter. The next sections (sections 2.4 to 2.4.4) introduce beef fifth quarter, along with its categorisation and present its current applications.

2.4 Beef Fifth Quarter Categories

As introduced in Chapter 1, the term beef fifth quarter refers to all parts of the cattle that are not part of the dressed meat carcass (Marti, 2011; Galanakis, 2012). The term originates from the expression "Quinto Quarto" which was used in Roman culture to describe the division of a beef carcass. The first "quarto" was sold to the nobles, the second to clergy, the third to artisans and merchants, and the fourth to the soldiers. The proletariat could afford only the leftover, called the "fifth quarter".

As shown in Figure 2.1 below, beef fifth quarter parts account for up to 54-56% of the total live bovine weight (Marti et al., 2011; Rabobank, 2012). Fifth quarter is divided into the following categories: offal (red and green), co-products, and animal by-products (ABPs) (Marti et al., 2011). Many offal and co-product materials are considered to be edible for humans, though according to European Union Regulation (Regulation EC No 1069/2009) all ABPs are deemed unsuitable for human consumption. Here, it has to be made clear that the term ABPs as reserved by the EU should not be confused with the term "by-products" used by scientists and food industry referring to edible applications mentioned earlier. Beef fifth quarter categories (i.e. offal, co-products and ABPs) will be detailed in the following sections along with their current applications.

[6] The Food Wise 2025 is the strategy that sets out a ten year plan for the Irish agri-food sector and is agreed by a committee of 35 stakeholders from the agri-food sector.

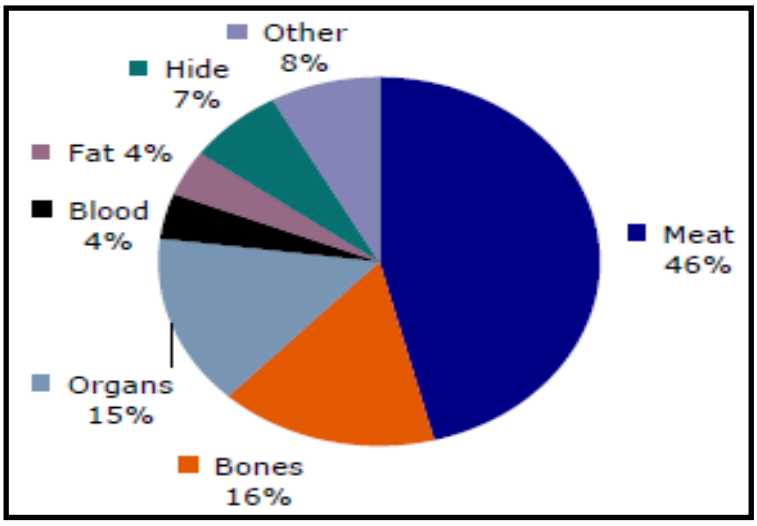

Figure 2.1 *Amount of cattle prime cuts and fifth quarter in a bovine animal (Source: Rabobank, 2012)*

2.4.1 Offal and its typical use in the food industry

Offal consists of the directly edible products (mainly prepared and cooked from fresh) usually called red offal and the indirectly edible (mainly incorporated into manufactured products) called green offal (Quality Meats Scotland, 2009) (see Table 2.1). Depending on the region and the targeted market these materials can be segregated, chilled, and processed during the cutting and stripping of the meat carcass (Jayathilakan et al., 2012; Liu, 2002)

Table 2.1 *Main offal materials and edible opportunities*

	Product	Likely consumption	
		Direct*	Incorporated into food products
Red offal	Blood	-	✓
	Brain[7] (under 12 months)	✓	✓
	Cheeks & head trim	✓	✓
	Heart	✓	✓
	Kidney	✓	✓
	Liver	✓	✓
	Thin skirt (diaphragm)	-	✓
	Tripe	✓	✓
	Omasum	✓	✓
	Pizzle	✓	-
	Tail	✓	✓
	Testicles	✓	✓
	Tongue	✓	✓
	Feet	-	✓
Green offal	Lips	-	✓
	Ears	-	✓
	Snout	-	✓
	Lung	-	✓
	Spleen	-	✓
	Pancreas	-	✓
	Udder	-	✓

Note: * Direct defined as prepared and cooked from fresh
Source: Adapted from Quality Meats Scotland (2009)

Red offal consists of the non-carcase products of the animal which can be sold directly for human consumption without further processing although cooking is of course required (EBLEX, 2014) (see Table 2.1). Red offal is widely consumed when cooked but is also used as ingredient in many types of processed meat products such as burgers, sausages, meat pies and in spreadable products such as pâtés. Liver, heart, kidney, and tripe for example have good nutritive value (Honikel, 2011) and constitute part of the diet in different countries worldwide (Nollet and Toldrá, 2011).

[7] Brains from cattle over 12 months old are banned for human consumption

Cooked and diced heart is consumed traditionally in South America and kidney is traditionally consumed in UK in steak and kidney pies (Toldrá et al., 2012).

Green offal consists of materials that are unsuitable for human consumption when they are produced at the slaughterhouse and require further processing before they may become safe and palatable for human consumption (EBLEX, 2014) (see Table 2.1). Some green offal is consumed in traditional dishes in some countries (e.g. bread with spleen in Italy) (Toldrá et al., 2012). Many of these materials are used as meat extenders, binders of fat and water in processed meat products (Kenny et al., 1999, Toldrá et al., 2012, Jayathilakan et al., 2012), emulsifiers, vitamin additives, clarifiers, colour additives, and protein supplements, as well as milk substitutes and egg white replacers (Jayathilakan et al., 2012, Toldrá et al., 2012, Baiano, 2014, Liu et al., 2002).

It should be noted that categorising offal as edible depends on traditions, culture and religion, while regulations are also important, as many countries restrict the use of some of these products for food safety reasons (Jayathilakan et al., 2012). Florek et al. (2012) report that due to aforementioned reasons, edible offal is usually limited to liver, heart, kidney, tongue and thymus plus other sweetbreads, brain, and tripe while additional items are used in many cultures. Therefore, many offal products that are considered inedible in a country can be considered as precious delicacies in other countries (Liu et al., 2002, Toldrá et al., 2012, van Heerden and Morey, 2014)

2.4.2 Co-products and their typical use in the food industry

Co-products comprise of inedible materials (e.g. hair, hide and bile fluid) and edible materials which, however, are not suitable for human consumption in their unprocessed state (e.g. bones and fat) (Table 2.2). Co-products are used in the manufacture of food-grade fats, stock, broth and edible bone phosphate (Kenny et al., 1999). Collagen, produced from the hide and skin is used as an emulsifier, additive and filler in meat products, because of its ability to bind together large quantities of fat (Kenny et al., 1999). Gelatin, derived from collagen, has good gel-forming and binding ability that makes it of interest in the food industry for a wide

variety of applications such as desserts, candies, bakery, dairy, ice cream and frozen desserts (Jayathilakan et al., 2012, Toldrá et al., 2012) and in meat products as clarifying agent, stabilizer or protective coating material (Djagny et al., 2001, Kenny et al., 1999)

Table 2.2 *Main beef co-product materials and edible opportunities*

	Product	Likely consumption	
		Direct*	Incorporated into food products
Co-products	Fats	-	✓
	Skin	-	✓
	Bones	-	✓
	Connective tissue	-	✓
	Membrane	-	✓
	Hair	-	-
	Bile Fluid	-	-

2.4.3 Animal By-products

While the categorisation and utilisation of offal and co-products is dependent on factors such as culture, customs and market demands, the definition, use or disposal of ABPs is strictly governed by legal regulation. European legislation (Regulation EC No 1069/2009) defines ABPs as "*entire bodies or parts of animals, products of animal origin or other products obtained from animals that are not intended for human consumption*". The need for this legal framework comes from the potential risk that ABPs can pose on human health. Depending on the potential risk they may pose to public and animal health and to the environment, the regulation divides ABPs into three categories.

Category 1 ABPs contain very high risk material including the carcasses of animals suspected or confirmed of being infected with transmissible spongiform encephalopathies (TSEs); parts of animals that have been administered certain prohibited substances; and all specific risk materials (SRM) that have to be removed from the carcase and disposed of in accordance with Regulation (EC) No 999/2001. Category 2 ABPs includes animals that die on-farm; manure and the digestive tract content; and by-products from animals that exceed permitted residue levels of certain

permitted substances (e.g. therapeutic drugs). Category 3 ABPs includes materials which have previously been fit for human consumption, but which are not intended for human consumption for commercial reasons, or due to problems of manufacturing or packaging defects or because of their use for rendering into animal feed and pet food animal; by-products derived from the processing of products previously intended for human consumption (e.g. degreased bones and greaves). It is noted that under the same regulation once these parts are classified as ABPs, they can never be upgraded, but only downgraded from Category 3 to Category 1 (Regulation EC No 1069/2009). Materials from Category 1 can only be incinerated, whereas materials from Category 2 can be used as fertilizer, compost and anaerobic digestion plants after being rendered. Category 3 materials can be used for animal feed and pet food. The collection, transport, storage, handling, processing and disposal of by-products are carried out in the European Union (EU) in accordance with Regulation EC 1069/2009.

2.4.4 Non-human food uses of fifth quarter

In addition to typical uses of fifth quarter materials in food products that were discussed in the previous section, the utilisation of meat fifth quarter products has further evolved into other applications. Toldrá et al. (2016) reported the following applications: food applications, feed and pet food, energy generation, medical and pharmaceutical, fertilizer and chemical applications (see Fig. 2.2). As these applications are directed towards different industries, fifth quarter materials find use in different markets with their own characteristics. Consequently fifth quarter products can go through different supply chains than those of carcase meat (EBLEX, 2014).

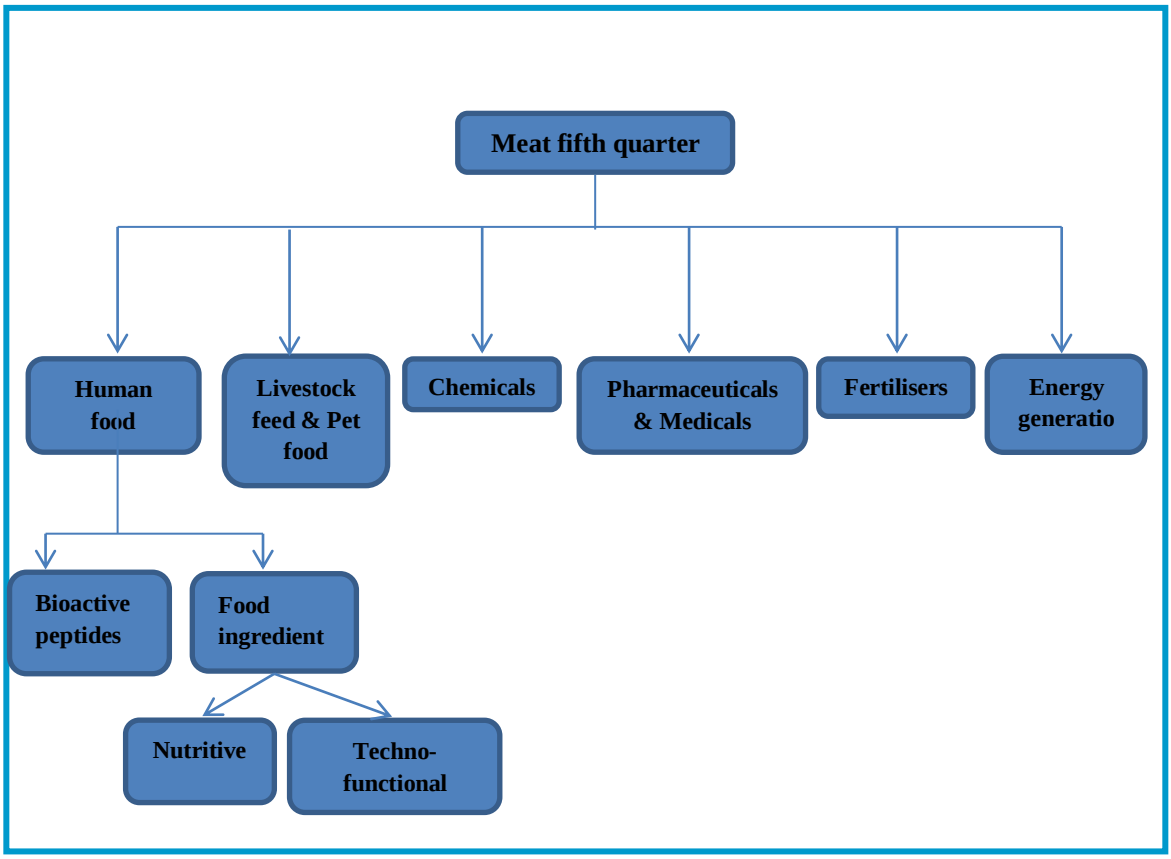

Figure 2.2 *Main routes for meat fifth quarter applications (source: adapted from Toldrá et al., 2016)*

One of the traditional uses of raw and rendered animal fifth quarter has been its incorporation as ingredients in pet foods and animal feed (Toldrá et al., 2016, Jayathilakan et al., 2012). The pet food market has always played an integral role in the meat industry (EBLEX, 2014). Many fifth quarter components are highly suitable for use in companion animal diets as they consist of nutritious components such as protein, fat and micronutrients (Toldrá et al., 2016). Also, meat and bone meal (MBM) and related rendered protein products form an important constituent in animal feedstuffs (Jayathilakan et al., 2012).

Animal fifth quarter also provides many of the raw materials used to make industrial products (Marti et al., 2012) with fertilizers, as well as, pharmaceuticals, chemicals and biodiesel production, being the main non-edible uses of meat fifth quarter (Mora et al., 2014). A short description for some of these applications follows.

In the medical industry, collagen is one of the most useful proteins (Mora et al., 2014) with gelatin and fat utilised as a binding and compounding agent for the manufacture of medicated tablets and pastilles and bile fluid utilised in capsules production (Liu et al., 2002, Jayathilakan et al., 2012). Moreover, rendered fat is used in a variety of cosmetic applications like hand and body lotions, creams and bath products (Toldrá et al., 2012). The apparel industry has traditionally used hides for leather-based products, shoes, belts, handbags and purses, gloves, etc. (Toldrá et al., 2012). The chemical industry uses collagen and gelatin as ingredients for paints, varnishes, cleaners and polishes among others (Pearl, 2004) and fatty acids, derived from rendered fat, are used for rubber and plastic polymerization, softeners, lubricants and plasticizers (Ockerman and Basu, 2006). Finally, in recent years, animal fat is used for biodiesel production replacing conventional diesel fuel (Toldrá et al., 2012).

2.5 Adding value to meat fifth quarter and its relevance to worldwide protein demand

As previously discussed, there is a large variety of potential applications for meat fifth quarter materials. However, in most of the cases significant amounts of these raw materials are hardly recovered and when they are they find use in low-value purposes (Lafarga and Hayes, 2014). The low economic value of these materials can sometimes lead to the mixing together and processing of materials which, if treated differently, could generate higher returns. So, while the utilisation of some of these materials for example, in feeds and fertilizers, are viable from economic and technological aspects (Bhaskar et al., 2007) and some countries have secured low value markets for many of these materials (Mullen et al., 2017, Bhaskar et al., 2007) science and innovation are assisting the meat industry to add value to all "non-meat" products (Toldrá et al., 2012). This requires a degree of innovation where these materials are subjected to processing to result in edible or inedible products (Toldrá et al., 2016).

A plethora of studies have highlighted that many fifth quarter materials contain high amounts of nutrients like protein, essential amino acids, minerals and vitamins (e.g. Jayathilakan et al., 2012, Florek et al., 2012, Álvarez et al., 2018a, Mullen et al.,

2017). These highly complex components can be extracted, leading to the development of new applications in food and non-food sectors with economic benefit (Mullen et al., 2015). To explain further, in many cases, valuable fifth quarter components when extracted from source materials can command a higher value than the original source material (Mullen et al., 2015). For example, blood plasma proteins are higher value than blood (Mullen et al., 2015). In the same sense, liver can be consumed braised, broiled, fried, in loaf, patty and sausages but can also result to high added value products when antioxidant peptides are extracted from it (Mullen et al., 2015). However, any approach to further exploiting the value of these materials may come with further costs. Ensuring that the final product will justify this cost is critical to the ultimate success.

Scientists are currently investigating and developing edible applications for meat fifth quarter (Mora et al., 2014). Specifically, the development of techniques for the recovery and the utilisation of protein from meat fifth quarter has gained a considerable interest in the recent years (Darine et al., 2010). This is primarily justified due to the fact that proteins are the main components of fifth quarter (Mullen and Álvarez, 2015).

Moreover, the recovery and utilisation of fifth quarter protein is linked to two important drivers: projections regarding the increase of the global population and the trend towards the use of high-protein diets in the developed world. The global population has reached 7.3 billion and is expected to reach 9.3 billion by 2050 (United Nations, 2015). This rise in global population should be considered in parallel with changing dietary preferences towards increased protein intake. Taking into account the higher income levels and increasing urbanisation in developing regions, it is estimated that this population growth will result in high demand for protein (Henchion et al., 2017).

General increase in the demand for protein is also fuelled by the latest report by WHO/FAO/UNU (2007), which estimates the dietary amino acid requirements for adults considerably higher than earlier estimates. Moreover, scientific research regarding the benefits of protein, besides muscle development, as for example on satiety and weight management (Veldhorst et al., 2008) and lately on hunger

stimulation targeting specific groups, have propelled in demand for protein (Henchion et al., 2017). In developed countries, protein has been a key trend for the last few years, moving from the domain of the elite athlete into the mainstream. This trend is reflected in high protein products lines across the food and drink market, from dairy and porridge to ready meals.

The challenge is to meet the increasing demand for protein through an environmentally, economically and socially sustainable approach (Bond et al., 2013). So far, protein production has been able to keep up with the population growth by intensifying animal production (Aiking, 2011). However, concerns arise that current production of animal-derived protein would not suffice to keep up with the population growth and the associated requirements for protein (Gilland, 2002). Therefore, it seems inevitable that new or alternative protein sources are explored (Verkerk et al., 2007). It is suggested that an important contribution to future human protein nutrition will have to come from sources that are not currently used for human consumption (Boland et al., 2013), or perhaps are not used to their full potential for human consumption. One of the source includes fifth quarter materials (Boland et al., 2013). Meat fifth quarter is a readily available and under-utilised resource for exploitation (Mullen et al., 2017), where available protein has potential to be used more effectively and efficiently.

It should be also noted that the increasing demand for protein and consumers' emerging diet trends, like eating less red meat, flexitarianism, eating a plant-based diet (Hoek et al., 2011) are driving the production and research of protein derived from novel and existing non-meat sources. These include protein from plant sources (e.g. soy, wheat, pea, rapeseed), from aquatic plants (e.g. microalgae, seaweeds, duckweed), from insects, and from fungi (van der Spiegel et al., 2013, Henchion et al., 2017). Academic research tends to approach plant and animal protein as diametrically opposed, due in part to different environmental, ethical and health issues related to them. Henchion et al. (2017) have stressed that the discussion around different sources of protein, should focus on a better balance of sustainable protein production and not on "good" and "bad" protein sources.

Research conducted in Ireland has highlighted that there are numerous opportunities to extract protein from beef fifth quarter and use it as ingredients in food products (e.g. Lafarga and Hayes, 2014, Mullen et al., 2017). The next section provides an extensive review of innovations in extracting protein from beef fifth quarter and of research recommendations for its applications in the food industry.

2.5.1 Innovation in fifth quarter protein applications for the food industry

More recent research in valorisation of fifth quarter protein for the food industry are related to their use of their functionality to improve nutritional properties of products, for exploitation of their techno-functional properties and for the generation of peptides with biological activity (Aristoy and Toldra, 2011, Zhang et al., 2010, Mora et al., 2014). Some of the latest research applications and developments are shown in Table 2.3 and discussed in the following sections. A graphic depiction of technologies reported is also presented in Figure 2.3, while technologies are further explained in Appendix I.

The content for Table 2.3 is based on a literature search conducted on papers from 2000 to 2018. This time limit was set as the focus was to review papers with technologies that hold a real opportunity for implementing, in the sense that technologies used few decades ago would not be useful for the aims of this research. Furthermore, an Internet search on commercially available products derived from fifth quarter was undertaken. Their inclusion provides an insight into which fifth quarter materials are already used in food industry and into the potential needs these products satisfy. Finally, while in this review the focus is on bovine fifth quarter materials, porcine source materials were also selected given the similarities in their characteristics and in the techniques used for processing them.

Table 2.3 *Uses of fifth quarter protein for high added-value food products*

Source	Product	Preparation/Processing techniques	Scale level	Target compound and applications	Reference/Company examples
Achilles tendons (B)	collagen	enzymatic hydrolysis by bacterial collagenase, chromatographic techniques	lab scale	**1,3-** bioactive peptides with ACE inhibitory activity. Possible use for antihypertensive functional foods	Banerjee & Shanthi (2012)
blood (B) & (P)	blood (B) & (P)	frozen, refrigerated or dried	industrial scale	**1,2-** blood uses in blood pudding, blood sausage, for flavouring	
	plasma proteins	centrifugation	industrial scale	**1,2-** functional proteins associated with solubility, gelling, binding, foaming, emulsifying and fat replacing properties. Also, protein supplement. Have been incorporated into products such as processed meat, pasteries, bread, cakes, soups, gravies, ice cream, yogurt	Essentia Protein Solutions, Veos NV, Sonac B.V, Lican Functional Protein Source,
	haemoglobin	centrifugation	industrial scale	**1,2-** functional proteins for natural colouring in processed meat products. Also, iron supplementation for meat products	Sonac B.V, Proliant, Essentia Protein Solutions
blood (B)	whole blood, plasma fractions	enzymatic hydrolysis with commercial enzymes, chromatography techniques	lab scale	**1,3-** bioactive peptides with ACE inhibitory activity. Possible use for antihypertensive functional foods	Hyun & Shin (2000); Janitha et al. (2002)
	haemoglobin	enzymatic hydrolysis with commercial enzymes, chromatography techniques	lab scale lab scale	**1,3-** bioactive peptides with antibacterial activity. Possible use as a preservative for storage and distribution of meat based products **1,3-** bioactive peptides with antibacterial and at the same time ACE inhibitory activity. Possible use for antihypertensive functional foods	Froidevaux et al. (2001); Daoud et al. (2005); Nedjar-Arroume et al. (2006); (2008) Adje et al. (2011)
blood (P)	haemoglobin	enzymatic hydrolysis with commercial enzymes, chromatography techniques	lab scale lab scale	**1,3-** bioactive peptides with ACE inhibitory activity. Possible use for antihypertensive functional foods **1,3-** bioactive peptides with antioxidant activity. Possible use in food products as a preservative for storage and distribution of meat based products	Yu et al. (2006) Chang et al. (2007)
	plasma fractions	enzymatic hydrolysis with commercial enzymes, chromatography techniques enzymatic hydrolysis with commercial enzymes	lab scale lab scale	**1,3-** bioactive peptides with antioxidant acivity. Potential use as natural antioxidant in foods	Liu et al. (2010); Wang et al. (2007) Xu et al. (2009)
bone (B)	bone (B)	frozen/fresh or refrigerated, mechanical deboning methods	industrial scale	**1,2-** bone soups, mechanically deboned meat for flavouring	
	collagen	chemical/ enzymatic hydrolysis	industrial scale	**1,2-** functional proteins. Used in collagen sausage casing and in different food, beverages and confectionary applications	Rousselot, Devro,Nutra Food Ingredients
	gelatin	partial hydrolysis of collagen	industrial scale	**1,2-** functional proteins associated with gelling behaviour (gel formation, texturizing, thickening and water binding capacity) and properties related to surface behaviour (emulsion and foam formation and stabilisation, adhesion and cohesion). Also enhance products' protein content. Finds applications in various industries such as meat products, confectionary,desserts, bakery, dairy, ice cream soups and gravies	Rousselot, Nutra Food Ingredients, Vyse Gelatin Company
	protein	repeatedly sodium chloride washes, acid precipitation and dialysis	lab scale	**1,2-** functional proteins extracted from beef bones were used to manufacture finely comminuted sausage products	Boles et al. (2000)
heart (B)	heart (B)	frozen or refrigerated	industrial scale	**1,2-** braised, cooked, luncheon meat, patty	
	proteins	acidic solubilization and isoelecric precipitation different repeatedly phosphate buffer washing	lab scale lab scale	**1,2-** functional proteins with high value protein, low ash, fat and cholesterol **1,2-** functional protein concentrate proposed as texturizing for processed meat and emulsion-type sausages	Dewitt et al. (2002) Ionescu et al. (2007)
heart (P)	tissue hydrolysates	enzymatic hydrolysis, chromatography techniques	lab scale	**1,3-** bioactive peptides with antioxidant activity. Could be used as natural source of antioxidants with potential application in certain processed meat products to prolong shelf-life	Damgaard et al. (2015)

Source	Product	Preparation/Processing techniques	Scale level	Target compound and applications	Reference/Company examples
liver (B) & (P)	liver (B) & (P)	frozen or refrigerated	industrial scale	**1,2-** braised, boiled, fried, patty and sausages	
liver (B)	sarcoplasmic protein hydrolyzate	enzymatic hydrolysis,chromatography techniques	lab scale	**1,3-** bioactive peptides with antioxidant activity with potential use as natural antioxidant in meat products	Di Bernardini et al. (2011)
lung (B) & (P)	protein	alkaline solubilization and isoelectric precipitation, membrane processes	lab scale	**1,2-** functional proteins comparable with industrial scale proteins (very good emulsifying properties, pork proteins show better gelling properties than egg white and beef plasma). Could be used in meat products as functional ingredients.	Selmane et al. (2008)
lung (B)	protein	alkaline solubilization and isoelectric precipitation	pilot scale	**1,2-** functional proteins with excellent emulsifying, good solubility and good foaming properties. Could be used as emulsifiers in elaborated meat products in place of the commonly used sodium caseinates	Darine et al. (2010)
skin (B) & (P)	collagen	chemical/ enzymatic hydrolysis	industrial scale	**1,2-** functional proteins. Used in collagen sausage casing and in different food, beverages and confectionary applications	Devro, Nutra Food Ingredients, Vyse Gelatin
	gelatin	partial hydrolysis of collagen	industrial scale	**1,2-** functional proteins associated with gelling behaviour (gel formation, texturizing, thickening and water binding capacity) and properties related to surface behaviour (emulsion and foam formation and stabilisation, adhesion and cohesion). Also nutritional benefit by enhancing protein content. Finds applications in various industries such as meat products, confectionary,desserts, bakery, dairy, ice cream soups and gravies	Rousselot, Nutra Food Ingredients, Gelita, Vyse Gelatin
skin (B)	gelatin hydrolysate	gelatin hydrolysis with commercial enzymes, membrane processes, chromatographic techniques	lab scale	**1,3-** bioactive peptides with ACE inhibitory activity. Potential applications in functional foods **1,3-** bioactive peptides with antioxidant activity. Potential applications as a natural antioxidant	Kim et al. (2001a) Kim et al. (2001b)
skin (P)	collagen	collagen hydrolysed by commercial enzymes, chromatography techniques	lab scale	**1,3-** bioactive peptides with antioxidant activity. Potential applications as antioxidant igredients	Li et al. (2007)
collagen (B) & (P)	bioactive peptides	enzymatic hydrolysis	industrial scale	**1,3-** specific physiological benefits. Applications in functional foods besides others.	Peptan, Gelita

Notes: (B)- bovine source (P)-porcine source
1- nutritional properties, 2- functional properties, 3- bioactive peptides

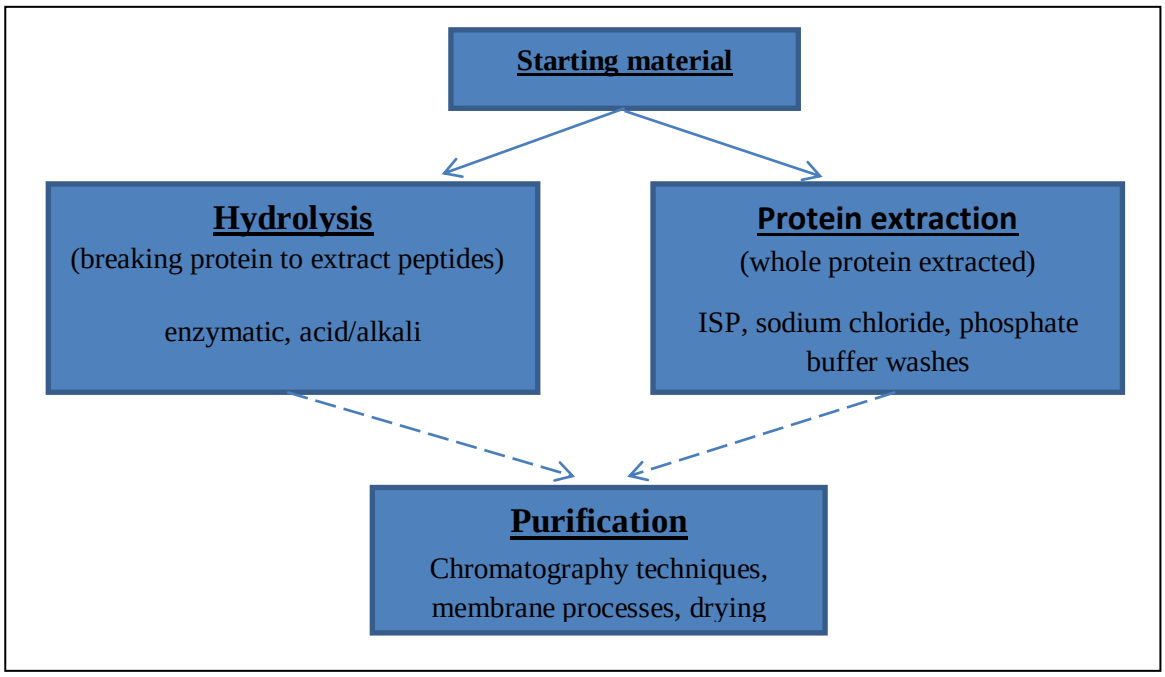

Figure 2.3 *Diagram of main processing technologies reported for protein extraction*

2.5.1.1 Nutritional quality of fifth quarter protein

Proteins have long been recognised for their nutritional properties which are associated with their amino acid content combined with the physiological utilization of specific amino acids upon digestion and absorption (Friedman, 1996). In general, offal is a good source of essential and limiting amino acids (Mullen and Álvarez, 2016).

Animal blood proteins have been well reported as a source of high-quality proteins for human consumption (Hsieh and Ofori, 2011, Bah et al., 2013, Lee and Song, 2009) and it has been suggested that their use may increase as worldwide protein demand increases (Ockerman and Basu, 2006). As discussed earlier, whole blood is traditionally consumed in products like black pudding and sausages. However, besides the aforementioned processed meat products, blood components' incorporation in other food categories in order to improve products' nutritional value is rather limited. One reason could be consumers' reluctance to choose blood derived products (MLA, 2015) besides these well-known products. While there are no recent estimations of blood usage in food industry, by 2001 it was estimated that only 30% of the blood produced in slaughterhouses was utilized by the food industry (Bah et al., 2013). Blood products destined for human consumption require large capital investment for hygienic collection systems; in contrast with centrifugation used for blood separation, which is an easy and common method used in industry settings to separate particles in a solid-liquid mixture (Galanakis, 2015). Nevertheless, it is necessary to develop procedures and applications that will permit the utilization of animal blood on a large scale (Bah et al., 2013) and scientist suggest some directions. A recent study argued that meat can be replaced by blood up to 20% in the formulation of sausages (mortadellas), yielding end products with high protein quality and digestibility (Fontes et al., 2015). Besides meat products, scientists have suggested the use of blood protein in pasta (protein-rich pasta) (Yousif et al., 2003), and in cookies (iron fortified cookies) (Walter et al., 1993).

As mentioned earlier, some fifth quarter materials such as heart, liver, kidney and blood are traditionally consumed. However, some other materials, like tail, ears and feet which have a protein content close to that of lean meat (Jayathilakan et al.,

2012) but low protein quality (i.e. absence of all essential amino acids), could still contribute to a final food product with balanced amino acid profile, when different ingredients are incorporated (Mullen et al., 2017). Considering the above, the production of protein from meat fifth quarter that can be used as added nutrients to foods is promising from technology perspective (Aristoy and Toldra, 2011), and thus may have potentials for manufacturers aiming to enrich common products or to develop products that meet the nutritional balanced requirements.

2.5.1.2 Techno-functional properties of fifth quarter protein

Functional properties of proteins refer to their contribution to the physiochemical and sensory properties of foods (Friedman, 1996). Within the food and beverage industry, proteins can impart techno-functional properties, such as influencing water holding capacity, viscosity, gelation, emulsification and foaming (Aristoy and Toldra, 2011, Mullen et al., 2017). These properties can add value to ingredients through improved shelf stability, improved sensory quality and better technological functions (e.g. gelling, binding, texturizing) (Toldrá et al., 2012). The relative importance of these properties depends on the food product being manufactured. One of the most studied and promising research line is the application of protein from meat fifth quarter in food products for exerting the aforementioned functions (Aristoy and Toldra, 2011).

As evident for Table 2.3, collagen is probably the most frequently used animal protein in food production (Mullen et al., 2017). As mentioned earlier, collagen is quite abundant in the carcass (Toldrá et al., 2012, Toldrá et al., 2016) but is mainly extracted from the animal skin and bones. Collagen can be extracted by either chemical or enzymatic hydrolysis with the latter being more expensive but more promising when products with high nutritional value and improved functionality are required (Schmidt et al., 2016). A variety of commercial collagen-based products are available for use in food products. Examples of companies supplying collagen ingredients include Rousselot, Collapro and Devro, who provide clean label binders, gelling and textural agents and collagen based sausage casing (Mullen et al., 2017).

Gelatin, obtained by partial hydrolysis of collagen, is also widely used in food products for its techno-functional properties (Gomez-Guillen et al., 2011).

Proteins found in blood's plasma fraction, also have relevant functional properties like gelation, foaming, and emulsification that prompted their use in the food industry (Hsieh and Ofori, 2011). Several companies have patented and provided commercial plasma protein for the food industry with applications as a binder in meat products, egg replacer, fat replacer, emulsifier and curing agent (Hsieh and Ofori, 2011, Lynch et al., 2017). However, besides the widespread commercialised available plasma proteins, scientific research is constantly exploring and suggesting possible "recipes" for their techno-functional applications. A recent study recovered protein from porcine blood plasma and incorporated it as meat protein replacement in Irish breakfast type sausage formulations resulting in an end product with strong potential both from a technological (i.e. improved water holding capacity, emulsion stability, less cook-loss) and nutritive perspective (i.e. essential amino acid content) (Álvarez et al., 2018b). Hurtado et al. (2012) also used porcine plasma as an ingredient in the production of frankfurters replacing the additives sodium caseinate and polyphosphate, resulting in an acceptable alternative formula to produce healthier and cheaper frankfurters. Rodriguez Furlán et al. (2014) investigated the effect of the addition of inulin and bovine plasma proteins, as fat replacers, on the quality of minced meat and found that the new formulations had nutritional advantages over full-fat samples and acceptable sensory profile.

While blood and collagen have received a lot of research attention and have had commercial success, scientific insight into functional behaviour of other fifth quarter materials is a more recent endeavour. Only in the last decade research has been published describing the extraction and characterisation of functional properties from various fifth quarter materials such as liver, heart, lung and bones (Mullen et al., 2017). In the majority of papers reviewed in this study, the techniques used for separation and purification of functional proteins were acid/alkaline solubilisation, followed by isoelectric precipitation (ISP) and membrane filtration processes. These conventional techniques are considered both safe and cheap (Galanakis, 2012) (see Appendix I for a short description of these conventional techniques).

Boles et al. (2000) extracted protein from beef bones to manufacture finely comminuted sausage products, by using technology traditionally used to prepare surimi from fish waste (i.e. buffer washes) and acid precipitation. In more recent studies, conducted by Selmane et al. (2008) and Darine et al. (2010) bovine and porcine lung extracted protein demonstrated strong gelling and emulsifying properties. In both studies proteins were solubilized under pH shift and recovered by isoelectric precipitation (ISP), whereas in the former study proteins were further purified by membrane processes. In relation to bovine heart, research on extraction of proteins by buffer washes (Ionescu et al., 2008) or acid solubilisation (DeWitt et al., 2002) has also shown that heart has potentials to act as a source of proteins with good techno-functionality.

Exploiting the variety of technologies which are currently available and commercially used by the dairy industry (e.g. membrane technology, ISP) to produce high value protein rich powders with techno-functionality properties may be an interesting way to investigate the feasibility of fifth quarter protein valorisation. It should be also noted here that protein extracted from meat fifth quarter with techno-functional properties needs to be assessed in food products to elucidate its interactions with other food matrix components and its impact on technological characteristics of the product.

Summing up, from a science perspective, an opportunity appears, for the meat industry to take advantage of protein-rich functional meat fifth quarter materials (Mullen et al, 2015). Introducing beef fifth quarter protein could be linked with the key market trend against artificial ingredients. There is an increasing consumer pressure towards additive-free products and replacement of synthetic ingredients with natural alternatives (Sigurdson et al., 2017, Santas et al., 2010, Hurtado et al., 2012). This trend may open an opportunity for these naturally derived proteins which are not synthetised in the lab and are sourced from natural raw materials.

2.5.1.3 Bioactive peptides from fifth quarter

Bioactive peptides are specific proteins fragments which beyond their nutritional capabilities, have a positive impact on the body's function or condition by

modulating metabolic processes (Kitts and Weiler, 2003). These biological functions can be exerted in one or several of the physiological systems in humans, including prevention of hypertension (ACE-I-inhibitory and antihypertensive peptides), opioid agonists, immunomodulatory, antithrombotic, antioxidant, anti-cancer or antimicrobial activities (Mora et al., 2014). Additionally, in food products the antioxidant and antimicrobial activity of these compounds can be used for improving the stability of foods in terms of shelf-life and bacteria confrontation. Synthetic antioxidants are usually added to foods in order to prevent lipid oxidation (Di Bernardini et al., 2011a, Saiga et al., 2003). Oxidation is one of the primary processes of food deterioration, resulting in limiting shelf-life and potential dangers for consumers' health (Simitzis et al., 2010). Also in terms of food preservation, synthetically-derived antimicrobials are used to enhance food safety by inhibiting the growth of food pathogens (Weiss et al., 2010).

The use of fifth quarter as a source of natural bioactive peptides has been extensively studied with recent innovative scientific proposals indicating fifth quarter bioactive peptides for the development of very high-added value products (Toldrá et al., 2016). Through the reviewed papers, the processes involved to separate and purify bioactive peptides from fifth quarter include enzymatic hydrolysis and chromatographic techniques (description of these techniques can be found in Appendix I).

Blood and collagen have been the most analysed fifth quarter materials as sources of bioactive peptides (Ryder et al., 2016, Lafarga and Hayes, 2014, Toldrá et al., 2016). Some blood's protein hydrolysates have been identified as exerting antioxidant, ACE-inhibitory, and antimicrobial effects with the last being the most studied (Adje et al., 2011, Nedjar-Arroume et al., 2008). In a lab scale, antimicrobial peptides have been isolated and purified from bovine haemoglobin (e.g. Daoud et al., 2005, Nedjar-Arroume et al., 2006, Adje et al., 2011). In other studies, antioxidant peptides were obtained from blood fractions with similar techniques (e.g. Yu et al., 2006, Chang et al., 2007, Liu et al., 2010). Bioactive peptides from blood fractions able to exert ACE-inhibitory activity were also extracted and characterized (e.g. Hyun and Shin, 2000, Janitha et al., 2002).

With regard to collagen, ACE-inhibitory and antioxidant activities of collagen hydrolysates have been mostly reported (Saiga et al., 2003, Mora et al., 2014, Di Bernardini et al., 2011b). Li et al. (2007) hydrolysed porcine skin collagen with commercial enzymes (protease) to generate four antioxidant peptides with bioactivities *in vitro*. In another study Kim et al. (2001b) hydrolysed bovine skin gelatin with commercial enzymes and identified antioxidant peptides. Banerjee and Shanthi (2012) identified peptides having ACE-I-inhibitory properties from bovine Achilles tendon collagen. Collagen was subjected to enzymatic hydrolysis and the hydrolysates were subjected to purification through chromatographic techniques.

Besides blood and collagen as a source of bioactive peptides, other meat fifth quarter parts have been studied to a lesser extent (Mullen et al., 2017). In another study, Di Bernardini et al. (2011b) isolated, purified and characterized a number of antioxidant peptidic fractions from porcine liver protein.

It should be also stressed that most bioactive peptides generated from meat fifth quarter have been studied *in vitro*, necessitating more *in vivo* experiments to establish the claims for identified bioactive peptides (Hyun and Shin, 2000, Mora et al., 2014, Lafarga and Hayes, 2014). Establishing the health claim is a costly and time consuming procedure requiring many experiments and scientific evidence. Moreover, when food stability is targeted, the bioactivity of these peptides should be tested in food products (Damgaard et al., 2015) in order for their effectiveness and the product quality to be confirmed.

Research outcomes suggest that the utilisation of meat fifth quarter derived bioactive peptides in functional food products could be an attractive option for meat processors (Lafarga and Hayes, 2014, Toldrá et al., 2012). Functional foods and beverage markets are growing and could potentially offer a valuable opportunity. A limited number of functional, peptide-based, products have been commercialised, with most of them using milk, plant and marine sources (Lafarga and Hayes, 2014). It is possible that commercial applications from meat fifth quarter can be expected in the future (Toldrá et al., 2012) as knowledge about the bioactivities and properties of peptides increases (Lafarga and Hayes, 2014). Moreover, the potential of these natural molecules to be used as preservatives may be of commercial interest given

the trend towards demand for natural ingredients (Daoud et al., 2005, Froidevaux et al., 2001, Nedjar-Arroume et al., 2006, Nedjar-Arroume et al., 2008) and the negative publicity that synthetic preservatives have received in the recent years.

2.5.2 Summary of fifth quarter protein opportunities for the food industry

Considering and reflecting on the added value opportunities mentioned above, it is critical to develop approaches that aim to exploit fifth quarter materials in their entirety, ensuring that all derived components are of commercial value (Waldron, 2007) and no further waste is produced. The benefits derived from the applications reviewed so far are depicted in the following table (Table 2.4).

Table 2.4 *Fifth quarter protein added value opportunities for the food industry*

Potential application	Added value
Plain protein addition	• Nutritive value
Techno-functional properties	• Replace/reduce synthetic additives (e.g. stabilisers, emulsifiers, gelling/foaming agents, flavor enhancers) • Nutritive value
Bioactivity	• Determined health benefit (in functional foods) • Replace/reduce synthetic preservatives (e.g. antioxidants) • Nutritive value

Bioactive components generally represent a small percentage of the source material but they have potentials for the development of very high-added value product (Lemes et al., 2016, Toldrá et al., 2012). Besides their nutritive value, bioactive peptides have the potential to be used as a natural antioxidant replacing or reducing the use of synthetic preservatives in processed foods. Moreover, they have the potential to be used as ingredients in health promoting functional foods. However, establishing a health claim is quite challenging and constitutes a long term goal due to strict requirements. On the other hand, techno-functional/nutritive components will account for the largest portion of the source material (Mullen and Álvarez, 2015, Mullen et al., 2015). These components hold the potential to replace or reduce the use of synthetic additives, such as stabilisers, emulsifiers, flavour enhancers, in

processed foods. Ideally, combined these approaches have the ability potentials to generate higher value for the meat industry and contribute to waste reduction.

It should be noted that, while numerous research publications have described the extraction and characterisation of protein from different beef offal sources, lesser attention has been given to sensory aspects of food products incorporating these proteins. Henchion and McCarthy (2019) have stressed that for food products containing ingredients extracted from beef offal to hold commercial potentials, sensory properties (e.g. taste, texture and colour) need to be addressed. They further explain that all sensory aspects have to be acceptable in a way that "*a protein blended burger should have sensory characteristics that are consistent with consumers' expectations of a burger*" (Henchion and McCarthy, 2019, p. 241).

Besides the numerous opportunities for protein extracted from offal to be used in food products, there are some industry and consumer challenges that should be considered. These challenges will be discussed in the following section.

2.6 Challenges associated with incorporation of protein extracted from beef fifth quarter into food products

Meat industry associated challenges

Technical challenges arise regarding the processing and incorporation of beef fifth quarter extracted protein into food products. These challenges are primarily linked to current meat industry practices on how fifth quarter products are collected, handled, stored and processed (EBLEX, 2014). These factors determine the access of fifth quarter products into the food supply chain. An example is the UK market, where fifth quarter products which are not popular on the domestic market tend to go into the ABPs categories and therefore cannot be further exploited for human consumption (EBLEX, 2014). No access to freezers to chill these products and thereafter export them is the reported reason explaining why these products are not exported (EBLEX, 2014). Moreover, some plants are losing market opportunities because body parts are hitting the factory floor, which immediately classifies them as ABPs and prevents them from entering the food chain. Encouraging optimal

utilisation of fifth quarter products, early in the production chain, can help to their valorisation before they become unsuitable for further exploitation (Baiano, 2014, Mullen et al., 2017).

Moreover, challenges regarding the valorisation of fifth quarter products are associated with many business factors such as the size of the operation (and therefore the volume of materials to process), the available space and equipment capacity, the staff availability and training and the access to markets (Ockerman and Hansen, 2000). Clearly, the extraction of the high-value components must be economically feasible. However, there is a lack of technical reports on costs and on the economic viability of such investment projects.

Baiano (2014) emphasized that exploitation of by-products "*is still in its infancy due the necessity to invest in research, new recovery technologies, and/or new production lines*" (p. 14836). The author suggested that valorisation of by-products might hold better potential through programmes that fosters collaboration between research institutions and industry and through the adaptation of already existing technologies (Baiano, 2014).

Consumer associated challenges

Besides the numerous opportunities to add value to beef by-products through protein extraction and incorporation into food products, market success of food products containing beef fifth quarter extracted protein is subject to consumer acceptance. Recommendations and solutions from scientific and policy perspectives should not be expected to be accepted by consumers (Henchion et al., 2016). Frewer and Gremmen (2007) indeed raise the concern that consumers may consider food products derived from by-products as unhealthy and waste and that "*unless consumers can agree that the benefits of by-products management are equivalent to sustainable, desirable and acceptable food production practices, consumers are unlikely to recognise and realise many of the potential benefits of by-products management*" (p. 32).

Recent food scandals and scares might contribute to consumers' outright rejection of food products containing ingredients derived from fifth quarter. Toldrá et al. (2012) stress the perceived health concerns attached to the meat fifth quarter and the link to Bovine Spongiform Encephalopathy (BSE), a disease that affects adult cattle, and when spread to humans results in variant Creutzfeldt–Jakob Disease (vCJD) leading to loss of physical mobility, dementia and death. Another example is the lean finely textured beef ("pink slime"), a meat by-product used as a food additive to ground beef and beef-based processed meats, which was banned from US school dinners after safety concerns. Trust in traceability of the food supply chain has been undermined after recent scandals such as the horsemeat scandal in 2013 in parts of Europe, when foods advertised as containing beef were found to contain undeclared or improperly declared horse meat. Assuring consumers of the safety of the fifth quarter is a prerequisite to acceptance.

2.7 Conclusions

The meat industry generates large volumes of by-products with significant amount of such by-products resulting in low-value products or being treated as waste with negative environmental and cost implications (Mora et al., 2014). This chapter has highlighted that improved utilisation of the beef fifth quarter has particular relevance for the Irish beef sector, and it has provided a contextual background to the opportunities for beef fifth quarter valorisation. Based on an extensive literature review, it is clear that opportunities arise for the extraction and incorporation of beef fifth quarter protein into food products. The chapter has shown that this opportunity is underpinned by forecasts regarding a global increase in food demand, particularly food of high protein content. It is proposed that making better use of meat fifth quarter protein could respond to this need, and at the same time reduce the environmental impact of increased meat production. The review undertaken reveals that proteins extracted from offal are mostly investigated for their applications in the food industry. Therefore, for the remainder of this study, focus will be given to protein extracted from offal, instead of general fifth quarter extracted protein.

Consumers' evaluations towards food products containing protein extracted from offal play a critical role and should be investigated prior to any commercial initiative

towards this direction. In the next chapter an overview of food choices and preferences will put consumers' attitudes towards products containing protein extracted from beef offal into a theoretical context in terms of the general determinants of food choice. A number of issues shape and effect food behaviour in general and the investigation into consumer attitudes towards a food product containing protein extracted from beef offal will be informed by these.

3 Factors affecting food choice

3.1 Introduction

To fully comprehend consumers' attitudes on incorporating protein extracted from beef offal into food products, a broader evaluation of the determinants of food preference and choice is a necessary precursor; this is the purpose of this chapter. An overview of the factors that have been found to influence food preferences and choices is presented through a number of different models. Biological, cultural and psychological factors are discussed with an emphasis on providing links and associations between theories in the areas of social psychology and food research.

3.2 Factors affecting food preferences and food choices

The Oxford dictionary defines preference as "*A greater liking for one alternative over another or others*", whereas choice is defined as "*An act of choosing between two or more possibilities*" (https://en.oxforddictionaries.com). In food studies, preferences can be described by integrating a behavioural component (Sijtsema et al., 2002) as they are learned through food experiences and eating (Birch, 1999), and can stand independently of consumption (Randall, 1981). The notion of food choice has been interpreted in many different ways. Food Standards Agency (FSA) provides the following definition: "*the selection of foods for consumption, which results from the competing, reinforcing and interacting influences of a variety of factors. These range from the sensory, physiological and psychological responses of individual consumers to the interactions between social, environmental and economic influences, and include the variety of foods and the activities of the food industry to promote them*" (Buttriss et al., 2004, p.33).

Numerous scholars that investigate food preferences and food choices as determinants of various food related behaviours use these two terms interchangeably, notwithstanding the subtle differences between them. As it will be analysed in the following section, food preferences are formed early in life by breastfeeding or formula feeding, complementary feeding, parental and sociocultural factors and they continue to develop over time and they work as a significant precursor to food

choice. For the purpose of this chapter, academic research on factors affecting food preferences will be presented first, followed by factors affecting food choices, while it should be noted that these two terms are highly correlated.

3.2.1 Factors affecting food preferences

Human food preferences in everyday life are a description of behaviour (Rozin, 1990). As will be described below, individual and environmental factors work conjointly to produce people's food preferences.

The way people perceive food flavours, in terms of the basic tastes: sweet, sour, bitter, salty and umami, together with odour and texture, affect their food preferences (Garcia-Bailo et al., 2009, Drewnowski, 1997). Research has shown that there are some biological differences in the way people perceive the basic tastes and that some preferences may be predetermined (Drewnowski, 1997, Tuorila, 2007), such as the predisposition to prefer sweet and salty foods and to reject foods that are sour, bitter or novel (Birch, 1999). However, while perceived food sensory characteristics, and taste in particular, are critical determinants of preferences (Garcia-Bailo et al., 2009), it is not necessarily straightforward that sensory preferences predict food preferences (Frank and Van Der Klaauw, 1994).

What guides people's food preference appears to be more complex than just sensory liking for a particular food. Interestingly, while people's chemosensory perception is quite similar across cultures, their food preferences differ (Jaeger et al., 1998, Prescott and Bell, 1995). As genetics and physiological differences account for relatively little of the variance in food preferences, difference in food preferences based on cultural and contextual factors has been widely explored and provides an explanation for observed differences (Mela, 1999, Reed et al., 1997).

A person's culture plays a dominant role in influencing food preferences (Mela, 1999, Rozin, 1990). It seems that culture is the most informative demographic feature about a person for the prediction of food preferences and attitudes to foods (Rozin, 2006). Culture affects preferences due to the type of foods people are exposed to in their early life and also by determining their exposure to certain kind

of foods in their later life (Ludy and Mattes, 2012). Individuals' culturally based attitudes, values, beliefs and cooking practices shape and influence food preferences (Nestle et al., 1998, Rozin, 1990, Rozin and Vollmecke, 1986).

Literature suggests that some food preferences are a result of learned experience with food and eating (Nestle et al., 1998, Birch, 1999, Sullivan and Birch, 1994). First experiences with food flavours either through breastfeeding, when flavours from the mother's diet are transmitted to her milk (Birch, 1999) or through bottle feeding formulas chosen by parents/healthcare professionals, can affect infant's formation of flavour preferences and shape later preferences for flavours and foods (Mennella and Beauchamp, 1996, Sullivan and Birch, 1994). While experiences with food are set early in life, they continue to develop and evolve during a person's life (Nestle et al., 1998). Learning to associate sensory attributes of foods and their post-ingestion consequences also appears to be an important mechanism for preferences development (Shepherd, 1999). A flavour and a biological result can be linked through a positive or negative Pavlovian[8] reaction (Rozin, 2006). Acquired preferences for spicy foods, coffee and alcohol, tastes that would not be preferred in person's early life, are usually referred to as evidence supporting the view that food preferences can be learned and altered during a person's life (Clark, 1998, Drewnowski, 1997). Food learning mechanisms can also be linked to habitual consumption and habitually consumed foods might become preferred in comparison to similar products (Costell et al., 2010, Mela, 1999).

In food research, socio-demographic and socio-economic factors have been widely applied in order to explain variations in consumers' food preferences and choices (e.g. Furst et al., 1996, Randall, 1981). In particular, evidence suggests that age, gender, income, social status and education are associated with food preferences (e.g. Wadołowska et al., 2008, Ricciuto et al., 2006, Wansink et al., 2003, Rozin, 2006). Taking gender as an example, studies have shown that female respondents tend not prefer red meat less (Beardsworth et al., 2002, Kubberød et al., 2002) and prefer more vegetables and less energy-dense food than males (Wadołowska et al.,

[8] Pavlovian conditioning (i.e. an example of classical conditioning) is a learning procedure through which an association between two stimuli is learned. It was developed in 19th Century by the Russian physiologist Ivan Pavlov, who first systematically investigated this through experiments with dogs. Pavlov used a biologically potent stimulus (food) paired with a previously neutral stimulus (a bell).

2008, Cooke and Wardle, 2005, Rozin, 2006). However, while gender, age and social status, are significant for food preference, they do not account for very much variation (Rozin, 2006). According to Dagevos (2005), the explanatory power of demographic background variables has been decreasing in developed countries and a deeper understanding of socio-cultural and socio-psychological influences on consumer food consumption is needed.

Interactions across a range of factors shape individual preferences, which in practice may have less to do with the food itself, but rather with the consumer and the environment in which the consumer lives. As individuals' preferences are shaped through their experiences and associative learning, the environment in which a person lives influences these food experiences. Individuals' social networks, such as their reference groups, family members eating behaviours and factors such as product availability and accessibility, represent some of the influential factors within the food setting. Given the diversity of these contexts that food experiences occur around the globe, it is unsurprising that food preferences vary.

The numerous factors that might play a role in consumer food preferences and choices have been structured by different models. Three main approaches have been applied when developing and selecting frameworks, models and theories to investigate food preferences and choice: deduction, induction and translation (Sobal et al., 2006). Deductive models of food choice are derived from experience and observation of experts and are tested through survey works (Sobal and Bisogni, 2009). Inductively developed food choice models use qualitative research methods to conceptualize people's food choices (Sobal and Bisogni, 2009). Finally, the translation approach examines food choices by applying existing models that are used in order to explain other topics (Sobal and Bisogni, 2009). Models belonging in all three categories will be presented below as well as the links between the issues highlighted by different authors. The selection of the following models and frameworks reflects their influence within the food choice literature.

Randall (1981), developed one of the first well acknowledged models describing the factors that influence food preferences. In this, a deductive model divided the determinants of food preferences in three categories: product, person and

environment (Fig. 3.1). While this scheme presents factors which were separately found to be associated with food preferences in previous studies (Sijtsema et al., 2002), it is descriptive in nature as it lists these factors and does not identify casual relationships. Moreover, when this model was developed, in 1980's, demographic variables were commonly used to describe people's consumption behaviour, and therefore mostly demographic variables are considered in the model (Sijtsema et al., 2002).

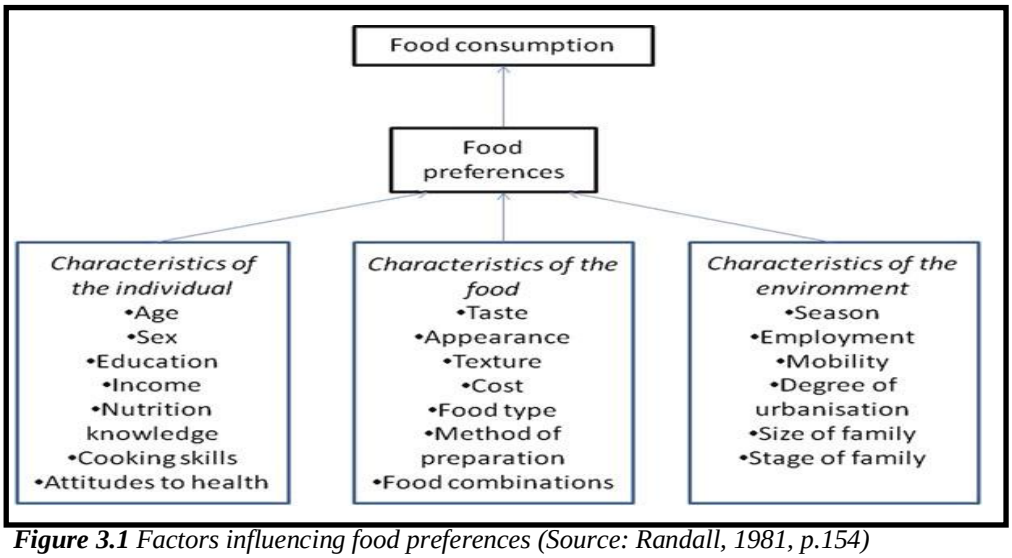

Figure 3.1 *Factors influencing food preferences (Source: Randall, 1981, p.154)*

3.2.2 Factors affecting food choices

As stated earlier, food preferences and choices are related. Food preferences imply choice (Rozin, 1990) and play a central role in determining food choices (Birch, 1999). Self-reported food preferences have been identified as one of the main predictors of food choices (Drewnowski and Hann, 1999, Woodward et al., 1996). However, food choices should not be deemed only as the result of individual food preferences. Food choices are determined by a variety of interacting factors where food preference might be only a part. The move from food preferences towards actual choice is modulated by a multiplicity of factors.

Shepherd (1985) classified food choice factors into three macro-categories: first, is the food-related factors which refer to physical or chemical properties of the food, nutrient content, and functional factors; second, is person-related factors including perceived sensory attributes of food and psychological factors and third is the external economic and social environment within which the choice is made,

including cultural and social issues, attitudes, availability, price and brand (Fig. 3.2). While Shepherd (1985) in his model does not make a distinction between food choice and food preference, many of the aforementioned factors that are reported to affect food choice are mediated by attitudes held by the individual. The position of attitudes in Shepherd's model is interesting as it highlights how the three components of food, person and economic and social factors are internalised by individuals through the formation of attitudes. So, for instance, consumers' attitudes about the health value of a food product may be more important than the actual health value of that food when consumers determine their food choice.

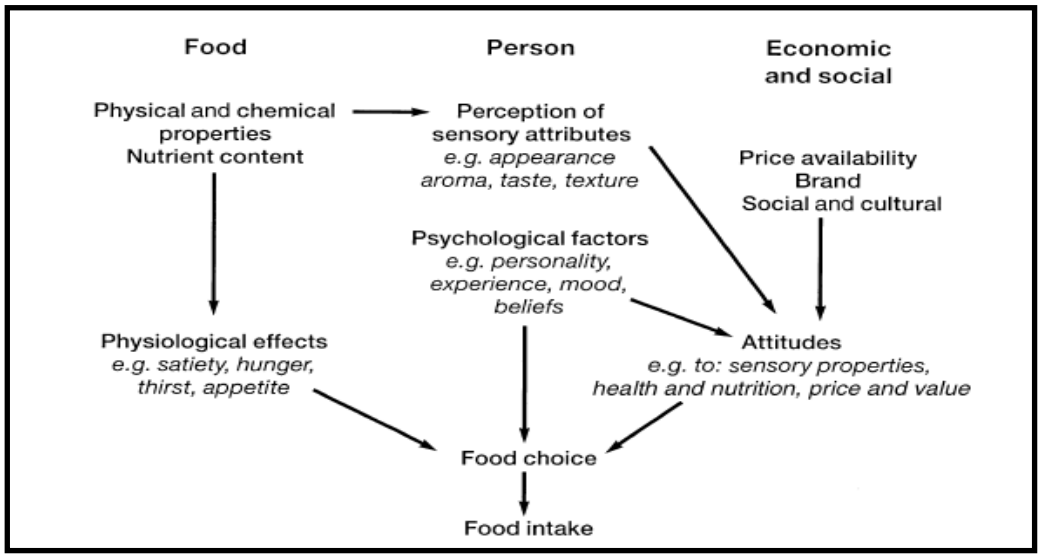

Figure 3.2 *Factors affecting food choices and intake (Source: Shepherd, 1999, p.808)*

Furst et al. (1996) argued that previous studies have focused on only selected aspects of the broad scope of factors involved in food choice. They applied a constructionist approach and qualitative research methods in order to develop a conceptual Food Choice Process Model (FCPM) that provided a holistic perspective of the factors influencing food choices. The scientific group elaborated the model through additional qualitative research (e.g. Bisogni et al., 2007) and Sobal and Bisogni (2009) developed and described the food choice process model that incorporates the three following main components: (a) life course events and experiences (b) influences and (c) personal food systems (Fig. 3.3)

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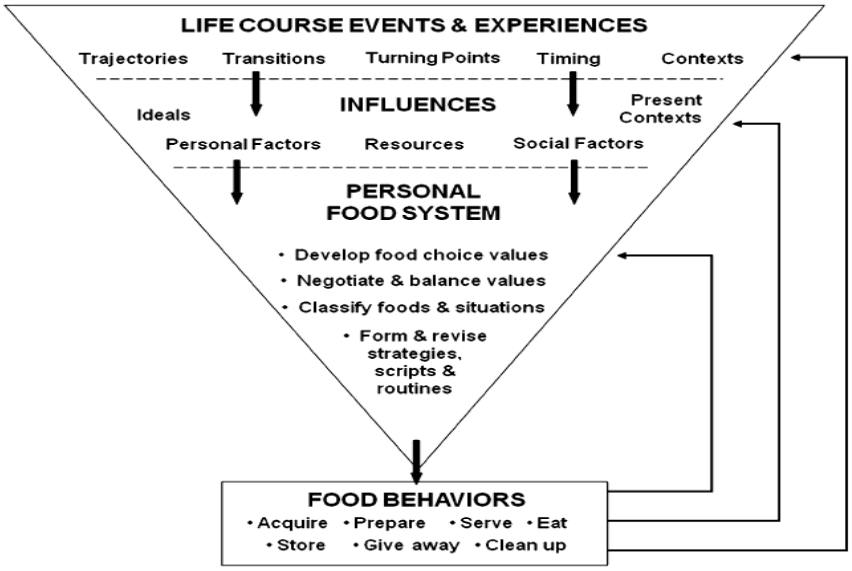


Figure 3.3 *A food choice process model (Source: Sobal and Bisogni, 2009, p.41)*

The life course component includes past experiences that individuals had, personal and social roles, and cultural and physical environments to which a person has been and is exposed (Furst et al., 1996, Sobal and Bisogni, 2009). Macro and micro level contexts (e.g. cultural and economic conditions, family, and friends) shape individuals' trajectories. Individuals' past food choices, thoughts and feelings associated with those choices compose individuals' life course trajectories of food choice (Devine, 2005). These food trajectories include peoples' persistent thoughts, feelings and strategies, and lead to eating patterns and food identities (Sobal and Bisogni, 2009). The developers of the model stressed that a person's life course provides precursors and context about current food choices and a framework for considering a variety of individual and contextual influences on food choices (Sobal and Bisogni, 2009). People's life course provides the underlying source for many factors that shape food choices and should be considered carefully when investigating food choice (Sobal and Bisogni, 2009). Furst et al. (1996), have earlier

claimed that people's attitudes towards food may be formed according to the impact of their life course events and experiences.

According to the model, a person's life course generates a set of influences, which refers to ideals, personal factors, resources, social framework and the food context, compromising the second component of the model. Ideals appeared to be an important influence, with Furst et al. (1996) commenting "*Perhaps the most pervasive influence was that of ideals: expectations, standards, hopes and beliefs that provided points of reference and comparison by which people judged and evaluated their food choices. Ideals were rooted in and derived from cultural and symbolic factors*" (p. 252-253). Sobal et al. (2006), describe ideals as cultural norms people have learned through socialization and represent normative indicators about which foods are acceptable and preferable. Elsewhere, Gorton and Barjolle (2013) refer to ideals as "*the symbolic meanings people associate with food, such as social status and whether a particular good is regarded as 'proper food'*" (p.20). Furst et al. (1996), argued that individual's values and sense of identity are also reflected through ideals, while individuals' consider them in food selection and reflect them through their food choices.

The aforementioned influences shape people's personal system which is the model's third component. This includes food choice values, value negotiation and balancing, classification of foods, and development of strategies, scripts and routines. This component describes the cognitive processes and the unconsciously operationalized strategies involved in food choice decisions (Sobal et al., 2006). A central component of people's personal systems is the values salient to the person. People use a common set of core values in their food choices, such as taste, cost, health, time or convenience, and managing social relationships and attach particular meanings to these values (Furst et al., 1996, Sobal and Bisogni, 2009). In their personal systems, individuals construct values to choose, negotiate, and classify food options. People develop ways to achieve these values in different situations (Connors et al., 2001) and ways of negotiating and balancing these values when all cannot be met at the same time (Sobal and Bisogni, 2009).

The Sobal and Bisogni (2009) model provides a way to organize the many macro and micro level factors and processes involved in food choice, and highlights the move from macro to micro environment that ultimately concludes with individual choice. The components of the model interact, whereas it is obvious that this model illustrates a dynamic situation. It should also be noted that the model incorporates the influence of individuals' food preference implicitly through trajectories and personal factors.

Some components of the aforementioned model have clear linkages with other works. Rozin (2006), identifies the following three motives for choosing or rejecting foods: sensory properties (e.g. taste, appearance), consequences of ingestion (e.g. saturation, nausea) and ideational concerns (nature/origin of a food). A close examination of Rozin's work illustrates the connection of his observations with the first two levels presented in the food choice process model. Rozin (2006), suggests that understanding both the context and the history of the individual must be taken into account for understanding any food choice; an observation that is closely related to the life course events and experiences component of the food choice process model. Moreover, the author reports cultural values as the primary determinant of human food preferences, and argues that culture is probably the predominant influence on food choices. People live in a world highly determined by culture, which determines people's experiences with food, constrains all learning experiences with food, monitors the availability of foods and shapes meanings of food and general attitudes to food (Rozin, 2006). He also refers to social contexts and micro level factors such as family, admired others and peer preferences as influencing factors on food choices (Rozin, 2006). The author also stresses the influence of food rituals, meanings of food and individuals' beliefs about the food on food choices. Concepts which were also described as ideals in the influences component of food choice process model. Rozin (2006) through his psychologist lenses reinforces and confirms in parallel the attention given by sociologists (e.g. Bisogni et al., 2007, Sobal and Bisogni, 2009, Sobal et al., 2006) to life course events and experiences and influences on human food choices.

Conner and Armitage (2006) argue that social psychological research gives the best insight into food choices. Without neglecting other influences such as physiological or socio-demographic, they argue that their impact is mediated by social psychological factors (Conner and Armitage, 2006). They focus on Expectancy-Value Model (EV) and on the Theory of Planned behaviour (TPB) mainly, as the dominant social psychological models that have been applied to food choices and provided valuable insight into the determinants of food choices.

EV model (Fishbein & Ajzen, 1975) is based on the hypothesis that people tend to maximize desirable outcomes, through their decisions. So, among two or more foods, individuals would choose the one that is believed to produce the most desirable outcome. While there are many possible outcomes from choosing a food, those that appear to be important are the salient ones in a particular situation (Fishbein & Ajzen, 1975). Individuals' perceptions of these outcomes are formed through their interaction with foods, but also through socially transmitted values, which include beliefs such as healthy and unhealthy properties of foods and acceptability or not of foods (Conner and Armitage, 2006).

Food choice has also been a focus in a number of TPB studies (e.g. Lloyd et al., 1993, Sparks et al., 1992). According to the TPB (Ajzen, 1991), intention is derived from three independent determinants of behaviour (see Fig. 3.4). First, is the attitude towards the behaviour, second, the subjective norm and third the perceived behavioural control. The TPB framework has been extensively used for modelling food choice (Conner and Armitage, 2006) and a large number of empirical studies have validated it for the study of food choice (Gorton and Barjolle, 2013). In this approach, it is assumed that individuals' beliefs and attitudes mediate the influences on food choice (Shepherd, 1999). For example, consumer’s beliefs about the nutritional quality and health consequences of a food may be stronger factors than the actual nutritional quality and health effects (Shepherd, 1999). However, TPB has received extensively criticism (e.g. Köster and Mojet, 2007, Köster, 2009) and one of the reasons is some shortcomings in conceptualisation and implementation (Shepherd, 1999). Social psychologists have included some extra variables, like self-identity, perceived need, ambivalence (Conner and Armitage, 2006) and moral concerns (Shepherd, 1999) in the model for examining food choices.

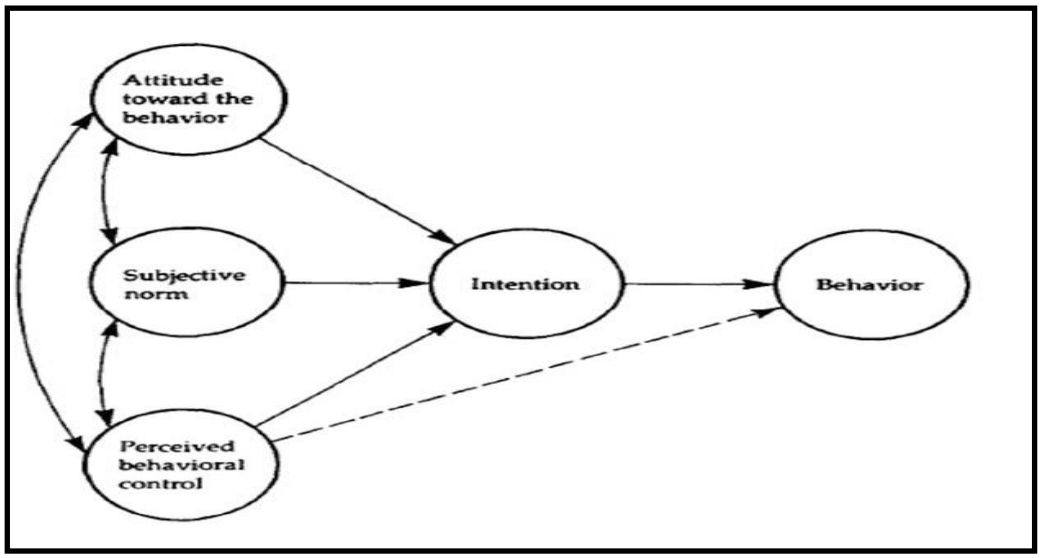


Figure 3.4 *Theory of planned behaviour (TPB) (Source: Ajzen 1991, p. 182)*

Zooming again into the component of "personal food system" of the food choice process model presented above, we could argue that EV and TPB models share similarities with the "personal food system" component of the food choice process model. EV and TPB models describe how individuals, based on their food choices, assign values to expected outcomes. These values are formed through learning beliefs that are shaped by individuals' lived experiences and influences (life course events and experiences and influences components of the food choice process model). Similarly, the "personal food system" of the food choice describes a process of food choice value construction where people assess what is important in food choice (Sobal et al., 2006).

Having examined the factors that influence food choices, it is clear that food choice is complex and that the impact of determinants is evolving continuously (Franchi, 2012, Köster and Mojet, 2007). As people develop and accumulate life experiences over time they are shaped by their environments and they engage in different food choice decisions (Devine et al., 1998, Devine, 2005, Sobal et al., 2006).

3.3 Conclusion

The purpose of this chapter was to provide an overview of the important factors that affect food choice and preference. The chapter described how different models

examine biological, psychological, cultural, social and product relevant determinants. This literature review revealed that when investigating factors affecting food product choice, it is important to consider the influence and interactions between the person and the environment. These influences and their impact change over time due to the evolving social, economic and physical environment. Most importantly, the literature explored indicated that most factors affect individuals' food choices through the formation of attitudes. Therefore, for a thorough understanding of food choice, an investigation of attitudes is required. This emerged from all models reflecting attitude's significance in food behaviour. The next chapter discusses the theoretical aspects and factors related to attitudes.

4 Attitude Formation and Information Processing

4.1 Introduction

The previous chapter presented a theoretical understanding of the factors that affect consumers' food choices. The important role of attitudes on food preferences and choices was stressed through different frameworks, models and theories. The purpose of this chapter is to provide an overview of the literature on attitude formation and information processing procedures which will inform the conceptual approach undertaken in this thesis on investigating consumers' attitudes to incorporating protein extracted from beef offal into food products.

Attitude constructs have drawn considerable attention within social psychology and remain core areas of investigation (Conrey and Smith, 2007, Olson and Kendrick, 2011). In this chapter, the attitude bases and the processes leading to the formation of attitudes are explored. The ways in which attitudes are formed are discussed through the most influential models and theories which explore how evaluations occur in deliberate or/and intuitive ways. In addition, attitude formation within the literature around attitude formation and information processing is discussed, stressing the dynamic relationship that exists between these two constructs.

Moreover, this review of literature identifies and addresses concepts that are relevant to attitude formation towards objects that are unfamiliar or contain some unfamiliar attribute. Specifically, the influence that attitude ambivalence exerts on information processing is outlined based on a review of empirical research in this area. Finally, the manner in which ambiguous information provision can impact attitude formation is also illustrated.

4.2 Attitude Formation

The attitude construct has gathered considerable scholarly attention across the social sciences and has held a central status in social psychology. Psychologist Allport (1935), one of the seminal early writers on the attitude construct, has referred to attitude as *"the most distinctive and indispensable concept in the field of social psychology"* (p. 789). The reason why attitude is practically and theoretically one of the most important concepts in social psychology and was never abandoned, is the

omnipresence of attitudinal influence (Conrey and Smith, 2007, Gawronski and Bodenhausen, 2007). Attitudes play a central role in individuals' everyday life by helping them to make sense of their environment, to define how they think and feel about objects and organisms, and by affecting decision making processes (Eagly and Chaiken, 2007, Fazio, 2007). Therefore, for social psychologists attitudes provide an important insight into people's evaluative judgments and contribute to a better understanding of decision making processes. It has been argued that people could not survive without attitudes and psychologists could not fully understand human behaviour without them (Olson and Kendrick, 2011).

The starting point in understanding attitudes is defining what an attitude is and exploring its origin. In the following sections attitude base, processes leading to attitude formation and attitude structure are investigated by exploring the seminal literature within the area of attitudes and related constructs (e.g. Fazio, 1990, Fazio, 2007, Eagly and Chaiken, 2007, Gawronski and Bodenhausen, 2007, Olson and Kendrick, 2011, Bohner and Dickel, 2011, Petty et al., 1997, Petty et al., 2006, Schwarz and Bohner, 2007)

4.2.1 Defining attitudes

As already mentioned, the attitude construct has a long history and its proper definition has experienced recurring theoretical controversies (Gawronski, 2007). Early definitions, while broad, stressed the enduring nature of attitudes and their high relevance to individuals' behaviour (Schwarz and Bohner, 2007). For example, Allport (1935) defined an attitude as "*a mental and neural state of readiness, organized through experience, exerting a directive and dynamic influence upon the individual's response to all objects and situations with which it is related"* (p. 810)

In the following decades, the attitude concept became more refined and authors presented definitions which focus on its evaluative components (Schwarz and Bohner, 2007). In their highly recognised book, Eagly and Chaiken (1993) defined attitudes as "*a psychological tendency that is expressed by evaluating a particular entity with some degree of favour or disfavour*" (p. 1). Eagly and Chaiken (2007), stressed the relevance and implication of the three key components of their definition

–namely tendency, entity (or attitude object), evaluation- to other relevant constructs associated with these components, such as attitude strength and attitude behaviour consistency. Petty et al. (1997), holding a similar perspective as Eagly and Chaiken (1993) conceptualised attitudes as generally positive or negative evaluations of objects.

Turning to a more recent definition, Crano and Prislin (2006) described attitudes by stressing the evaluative processes associated with an object: "*An attitude represents an evaluative integration of cognitions and affects experienced in relation to an object. Attitudes are the evaluative judgments that integrate and summarize these cognitive/affective reactions*" (p. 347). This conceptualisation encompasses the three classical variables – affect, cognition, behaviour- which have been traditionally used for understanding the attitude concept. Similar to this definition, Olson and Kendrick (2011) considered attitudes to *"encapsulate positive and negative feelings, beliefs, and behavioural information about all ranges of "attitude objects," from people to frozen pizza"* (p. 1).

While there is general agreement in literature on the notion that an attitude involves the evaluation of an attitude object, ranging from mundane to the abstract, on a dimension from positive to negative (Olson and Fazio, 2001, Van Overwalle and Siebler, 2005, Ajzen, 2001, Bohner and Dickel, 2011, Olson and Kendrick, 2011, Fazio, 2007), attitude research is divided in two important and distinct streams: attitudes as stable entities stored in memory versus attitudes as temporary judgements constructed on the spot (Gawronski, 2007).

At the stable-entity side, authors perceive attitude evaluations as learned responses to the attitude object (Bohner and Dickel, 2011, Fazio, 2007). A classical definition by Fazio (2007), who defends this view, describes attitude as "*an object-evaluation association in memory*". Bargh et al. (1992) also supported the view that attitudes are stored in memory, where they persist over time and from where they *"become active automatically on the mere presence or mention of the object in the environment"* (p. 893). Petty et al. (2007), also claimed that attitudes are best conceptualized as long term memory structures, however, they stress the possibility of the attitude object representation being linked to more than one summary evaluation. Conversely, a

growing body of literature contradicts the traditional notion of the enduring nature of attitudes (Schwarz and Bohner, 2007). On the constructionist side, it is assumed that evaluations are created on the spot, based on current contextual cues and existing knowledge (Eagly & Chaiken, 1993; Schwarz, 2007). A proponent of this perspective, Schwarz (2007) defined attitudes as *"evaluative judgments, formed when needed, rather than enduring personal dispositions"*. Aligned with the constructionist perspective, Conrey and Smith (2007) suggested that attitudes are "*time–dependent states of the system rather than static things that are stored in memory*". Bohner and Dickel (2011) in their selective review of literature from 2005 to 2009, summarised constructionist and memory-based definitions and highlighted that given the empirical evidence every definition proposed has its strengths and holds merit within different contexts.

This section has summarised some of the most influential definitions of the attitude construct and has introduced some important concepts that will be explored in this chapter. The following section will address one aspect of attitude construct that has drawn particular attention; the bases of attitudes.

4.2.2 Attitude bases

A number of distinct foundations have been suggested in order to shed light on the bases of attitudes (Crites et al., 1994). The classical ABC (Affect, Behaviour and Cognition) metaphor for understanding attitudes considers these three variables as components of attitude (Eagly and Chaiken, 2007). In attitudinal research, conceptualizing attitudes as having affective and cognitive bases has been one of the most popular approaches (Petty et al., 1997). Attitudes can stem from affective reactions that people experience when they encounter the attitude object and/or from cognitive beliefs that are attached to the attitude object (Fazio, 2007). Affect has been used to describe the positive and negative feelings associated with an attitude object, while cognition refers to the positive or negative beliefs one holds about the attitude object (Eagly and Chaiken, 2007, Fabrigar and Petty, 1999). For example, the cognitive basis of an attitude towards a food product could contain the positive and negative beliefs about the food (e.g. health consequences, convenience, nutrition value), while the affective basis could contain the sensations, feelings and emotions

one experiences in response to foods (e.g. taste, likes and dislikes, memories the food evokes). Researchers have largely adopted this distinction regarding the two sources of attitudes (Olson and Kendrick, 2011), however, in most situations pure affect-based or cognition-based attitudes do not occur (Edwards, 1990). The third basis of attitude draws on the idea that attitudes can have a behavioural genesis, as individuals' attitude judgments may be based on their information about their past behaviour towards the attitude object (Albarracín and Wyer Jr, 2000). By providing a series of empirical evidence, Olson and Kendrick (2011) exemplified that when cognitive or affective bases are absent individuals can infer attitudes towards attitude objects by monitoring their own past behaviour.

Beyond the ABC model, Ajzen (2001) and Petty et al. (1997) have outlined that the functionality of attitudes can serve as a basis of attitudes. This perspective aligns with the functionalist theory by Katz (1960). This theory classifies four functional areas of attitudes: the ego-defensive function, in which attitude is held to protect self-esteem; the knowledge function, in which attitude provides a structure for interpreting the meaning of an attitude object; the value expressive function, in which the attitude is a reflection of important values; and the adjustive function, in which attitude is held to assist utilitarian needs and avoidance when needed. Katz's theory stresses that attitudes arise and change in order to satisfy individuals' motivations and needs. This approach implies that it is not the information about an attitude object that influences attitude formation and change but rather individuals' underlying personality needs.

Another interesting approach is that some attitudes appear to have some genetic basis (Petty et al., 1997, Olson and Kendrick, 2011). For example, attitudes towards death penalty, drinking alcohol, censorship, authoritarianism and others, have been found to be heritable (Olson and Kendrick, 2011). Explanations of the high heritable indices that some attitudes have, relate these heritable attitudes to other personality traits which have been found to have genetic components (e.g. intelligence, extroversion) (Olson and Kendrick, 2011). Research in this domain challenges the traditional attitude research which places experience as an inherited part of attitudes bases (Petty et al., 1997). Opponents of the genetic basis of attitudes have argued that genetic research of attitude bases carries important methodological and

empirical limitations and provides only narrow insight to a limited number of few attitudinal domains (Petty et al., 1997, Olson and Kendrick, 2011). In relation to food attitudes, it has been claimed that genetic differences in sensory structures might affect attitudes towards certain food (Tesser, 1993). However, as discussed earlier (see section 3.2.1) genetic differences account for relatively little of the variance in food preferences.

This section has given an insight of the multiple sources involved in attitude formation. Identifying the base of attitude is significant to other relevant issues of attitude construct such as the processing of new information which will be examined in following sections. The next section further examines the multifaceted processes that lead to attitude formation.

4.2.3 Processes leading to attitude formation

As previously illustrated, social psychologists have made substantial progress in understanding what attitudes are and where they stem from. However, numerous scholars (e.g. Olson and Fazio, 2001, Van Overwalle and Siebler, 2005, Glöckner and Witteman, 2010, Eagly and Chaiken, 1993) have argued that the majority of social psychology has historically focused more on questions regarding attitude structure and function, attitude change, and attitude-behaviour consistency rather than on attitude formation and related processes. For example, Eagly and Chaiken (1993) highlighted that the *"lack of attention to the development issue of how attitudes form"* is "*a serious omission and limitation*" (p. 681)

Olson and Kendrick (2011) outline how current research emphasis has been placed on revealing the complex processes leading to attitude formation, independent of an attitude's specific content. In terms of underlying processes, in some cases attitudes seem to come to mind relatively effortlessly, quickly, unintentionally and without much conscious awareness of their formation, while in other cases, attitudes are consciously controlled and arise from intentional, conscious and thoughtful consideration of attitude-relevant information (Kruglanski and Gigerenzer, 2011, Pachur and Spaar, 2015, Marquardt and Hoeger, 2009, Olson and Kendrick, 2011). These distinct processes have been given different names, but more important is how

they are defined rather than any specific label given to them (Evans, 2008). The first process, called intuitive within this thesis, reflects relatively automatic associations between an object and an evaluation and result in a feeling of "knowing without knowing why" (Glöckner and Witteman, 2010, Evans, 2010). The second process described, called deliberative within this thesis, is an analytic mode that requires individuals to think at complex levels and critically make evaluative judgments (Epstein, 2010).

Delving deeper into these processes is crucial, as it is expected that different processing strategies by different individuals lead to different attitude outcomes and exert different influences on other related phenomena such as information processing. A description of the most influential theories and models which explore the complexity associated with attitude formation, through the aforementioned processes, is provided in turn.

4.2.3.1 Attitude formation through intuitive processes

In the early phases of attitude research, attitude formation has been approached by models that stress the importance of affective processes (Eagly and Chaiken, 1993) with evaluative conditioning procedures being the most prominent example (Crano and Gardikiotis, 2015, Walther and Langer, 2011). Evaluative conditioning (EC) refers to an observed change in the evaluation of a stimulus, termed conditional stimulus (CS) caused by repeated pairing with a stimulus that holds positive or negative valence, termed unconditioned stimulus (US) (De Houwer et al., 2005). In most cases, the CS has initially neutral valence and becomes more positive (or more negative) after being paired with a positive US (or negative US) (De Houwer et al., 2005). EC approach has received considerable empirical support in many studies (Bohner and Dickel, 2011) and there is some evidence that attitudinal conditioning can occur at a sub-conscious level with the conditioning effect being highly resistant to extinction (Crano and Prislin, 2006, De Houwer et al., 2001, Walther and Langer, 2011).

In food-related literature, EC has been shown to influence individuals' evaluations for food stimulus by pairing it with stimuli that have positive or negative valence

(Lebens et al., 2011, Bui and Fazio, 2016). For example, Lascelles et al. (2003) showed that EC can change affective evaluations of foods. More specifically, the authors paired the conditioned foods with pictures of obese women and found that compared to preconditioned assessments, affective evaluations of conditioned foods became more negative after the EC procedure. In another recent study, Bui and Fazio (2016) applied evaluative conditioning to enhance automatic evaluations of healthy eating behaviours. The authors paired healthy CS foods with positive US and unhealthy CS foods with negative US and found that EC influence participants' perceived importance of health consideration for their food choices.

Similar to the conditioning research, mere exposure research shows that attitudes can form due to intuitive mental processes alone without reliance on cognitive processes (Olson and Kendrick, 2011). This theory of mere exposure suggests that repeated exposure to an object leads to an increased positive affect or a reduced negative affect toward that object (Zajonc, 1968, 2001). This effect cannot be attributed to recognition memory (Zajonc, 2001), and researchers have put forward several explanations for its occurrence. Almost three decades after early research on mere exposure, Zajonc (2001) proposed that mere exposure effect can be viewed as an example of conditioning in which the absence of aversive consequences serves as a rewarding unconditional stimulus. However, the most widely accepted interpretation is based on a perceptual fluency mechanism where prior exposure enhances the ease with which individuals can process the stimuli in the next encounter and therefore, the same stimulus is evaluated more positively when it can be processed with high as opposed to low fluency (Matthes et al., 2007).

4.2.3.2 Attitude formation through deliberative processes

Some theorists have challenged the approach that attitudes can form by the mere association of affective cues and have argued that attitude formation is confined to cognitive processes. The Expectancy-Value Model (Fishbein & Ajzen, 1975) is perhaps the most influential model in order to explore how attitudes can emerge from beliefs through the process of cognitive reasoning (Albarracín et al., 2011, Van Overwalle and Siebler, 2005, Olson and Kendrick, 2011). This model assumes that attitudes are a function of individuals beliefs about the object (Olson and Kendrick,

2011, Ajzen, 2001). According to Ajzen (2001) "*each belief associates the object with a certain attribute and a person's overall attitude towards an object is determined by the subjective values of the object's attributes in interaction with the strength of the associations*" (p. 30). In this model, only salient beliefs (i.e. highly accessible in memory) are hypothesised to combine additively to form an overall evaluation of the attitude object at any given moment (Ajzen, 2001).

Aertsens et al. (2011), used the Expectancy Value Model to demonstrate how beliefs, combined with values, determine attitudes towards organic foods. They hypothesised that individuals' attitudes towards organic food is the sum of the salient beliefs concerning the attributes of organic food, multiplied by the value attached to these attributes. The authors claimed that "*as values are generally understood to be extremely stable constructs*" new knowledge about organic foods may change people's beliefs and therefore their attitude towards these foods (Aertsens et al., 2011, p. 1354).

In another study, Sparks and Shepherd (2002) addressed Expectancy-Value Based Theories to asses participants' attitudes toward food produced by genetic engineering techniques and towards meat consumption. They found that individuals' perceived moral obligation showed predictive effects on their attitudes towards these food issues. Given their results and rising ethical consumerism, the authors stressed the need to consider the role of moral evaluations when exploring food evaluations and choices.

Another model that also shares the assumption that evaluative judgments occur in a conscious and deliberative way and shares merit with the Expectancy-Value Model is the Information Integration Theory by Anderson (1971). This model asserts that the processing and interpretation of new information is integrated with current beliefs and attitudes in a process similar to that of Expectancy-Value model, and that integration produces an attitude (Olson and Kendrick, 2011)

As previously outlined, inherent in the Expectancy-Value model and the Information Integration Theory is the assumption that evaluative judgments occur in conscious and deliberative processing. For example, Fazio (1990) interpreting the Fishbein &

Ajzen (1975) model, argues that "*deliberative processing is characterized by considerable cognitive work. It involves the scrutiny of available information and an analysis of positive and negative attributes, of costs and benefits*" (p. 88-89). However, the view that information is processed exclusively deliberatively is not in total accordance with more current views. The more contemporary dual-process view on attitude formation attempts to address both intuitive and deliberative processes simultaneously rather than alternately (Marquardt and Hoeger, 2009).

4.2.3.3 Dual-Process Theories and Two-System Models

Largely adopted for exploring attitude change, but certainly applicable to attitude formation when no prior attitude exists, is a group of information processing theories, known as dual-process models (DPMs) (Olson and Kendrick, 2011). These models describe how attitudes can form by way of two distinct processes. Numerous authors have used different names for these processes and have ascribed different characteristics to them, but they all draw a qualitative distinction between attitude formation that is accomplished on the basis of relatively effortful processing of information or on the basis of relatively low-effort processing of more peripheral forms of information (Pachur and Spaar, 2015, Evans, 2008, Kruglanski and Gigerenzer, 2011). Another common thread across the dual- process models is the attempt to specify the cognitive and motivational factors that determine which of these two processes is more likely to occur (Evans, 2008).

In light of DPMs scientific support and appeal, Evans (2008) reviewed them closely and claimed that "*generic dual-system theory is currently oversimplified and misleading*" (p. 270). He suggested the classification of dual-processing models into (a) models that propose a clear distinction between the two modes of processing (b) models that assume a "parallel-competitive" activation of both modes and (c) "default-interventionist" models which assume a sequential relationship with automatic processing being activated first and, if necessary, followed by deliberate processes.

Exemplars of long-established DPMs are the Elaboration Likelihood Model (ELM) (Petty and Cacioppo, 1986) and the Heuristic-Systematic Model (HSM) (Chaiken,

1980). The ELM suggests that information is processed through either the "central" route which involves in-depth cognitive analysis of information in order to obtain a carefully considered evaluation, or through the "peripheral" route which involves a wide range of low-effort mechanisms such as the use of heuristics and mere exposure (Bohner et al., 2011). According to ELM, when motivation or cognitive ability for analytic processing of information is low (e.g. low personal relevance, limited time) individuals use the peripheral route (Bohner and Dickel, 2011, Bohner et al., 2011). Heuristic processing, which is just one of the peripheral processes for the ELM (Haugtvedt and Petty, 1992), implies that people form attitudes by using situational cues, that automatically activate inferential rules, schemas, and knowledge structures such as "experts can be trusted", "majority opinion is correct", "I agree with people I like" etc. (Van Overwalle and Siebler, 2005). These heuristics are presumed to be learned and stored in memory and applied by providing default responses (Evans, 2008). However, although heuristic processing entails little effort, its occurrence requires that there is cognitive accessibility and availability of relevant heuristics in memory and that the situation provides cues that can be processed heuristically (Bohner et al., 2011). Connecting with the issue of attitude stability discussed earlier, Ajzen and Cote (2011) support the argument that attitudes formed via the central route are more persistent than those formed through the peripheral route.

ELM has been extensively applied in attitude literature to assess attitude change but has also attracted attention in the food risk area (Hansen et al., 2003). Frewer et al. (1997) applied the ELM in a food risk study, where they investigated the impact of risk types and source credibility on individuals engagement in elaborative cognitions about risk messages. The authors reported that perceived personal relevance was also influential in determining whether elaborative processing occnovel aurred. In a later study, the same group of authors, Frewer et al. (1999), conducted an ELM based study to investigate the impact of information source credibility and personal relevance on attitudes to genetic engineering in food production. In that study, the results acquired were not what was predicted by ELM (Hansen et al., 2003). Specifically, the authors found that low persuasive information from a trusted source and high persuasive information from a distrusted source led to the most elaborate cognitive processing. The authors stated that the unexpectedly provoked high

cognitive processing was triggered by a "suspicion bias". The study also showed that participants with low personal relevance engaged in more elaborate cognitive processing than did participants with high personal relevance. The authors argued that in situations where people feel "powerless" to influence the outcome, elaborate information processing is not initiated.

Walters and Long (2012) used the ELM as a framework for understanding the influence of individuals' knowledge on processing the information presented on food labels. The study sample consisted of experts and novices in nutrition in order to explore the effect of involvement and knowledge on label information processing. Two types of label information were given to participants: intrinsic cues related to the physical properties of the products (e.g. ingredients) and extrinsic cues related to characteristics externally attributed to the product (i.e. health and nutrition claims). The results obtained were in accordance with the elaboration likelihood model, showing that experts used the central route to process intrinsic cues and evaluate the food products, while, novices used the peripheral route to make simple inferences about the extrinsic cues on labels (Walters and Long, 2012).

Eagly and Chaiken (1993) have criticised ELM's degree of precision claiming that while, it allows the possibility of central and peripheral processes co-occurrence, it does not specify the conditions under which this may happen. Therefore, according to Evans (2010) categorisation, presented earlier, ELM lends itself more to the models that assume a clear cut distinction.

Similar to ELM, HSM (Chaiken, 1980) describes how attitudes can form through "systematic" processing which involves comprehensive consideration of object-relevant information, high levels of motivation and ability to engage in effortful processing or in contrast through "heuristic" processing which involves the use of learned knowledge structures in the form of heuristics to reach evaluations (Bohner et al., 2011). Although HSM and ELM share similar perceptions of "systematic"/"central" route, they differ in their definition of their low-effort mode. HMS's "heuristic" processing is defined more specifically than the ELM's peripheral route, comprising only the application of heuristics (Bohner et al., 2011). However, as in ELM, in HSM heuristic processing also requires some conditions in order to

occur, i.e. heuristics must be available in memory after being learned and stored there and they must be accessible for use in a given evaluation context (Zuckerman and Chaiken, 1998).

Another central element of the HSM, which differentiates it from ELM, is the assumption that individuals can engage in systematic and heuristic processing simultaneously with each process exerting either independent or interdependent effects on evaluation (Bohner et al., 2011, Moskowitz et al., 1995). The conditions of this interplay have been described in the following hypotheses. According to the model's *attenuation* hypothesis, systematic processing can entirely set aside the outcome of heuristic processing, and that is likely to happen when systematic processing is incongruent with the judgment implied from heuristics (Gawronski & Creighton, 2013). This occurs because the outcome implied by systematic processing is likely to be seen as more reliable than the one by heuristic processing and therefore the influence of heuristics is reduced (Zuckerman and Chaiken, 1998). According to the *additivity hypothesis*, information generated by heuristic and systematic modes may jointly influence evaluations in an additive manner if the two processes do not yield conflicting outcomes (Gawronski & Creighton, 2013). Finally, the *bias hypothesis* refers to the interaction between the two processes in conditions where information is ambiguous. In this case, information can be interpreted in line with a heuristic cue and bias the effects of systematic processing, even when individuals are highly motivated to engage in systematic processing (Gawronski & Creighton, 2013). Hence, HSM falls into Evans's (2008) "default-interventionist".

The *bias hypothesis* was supported in a study by Chaiken and Maheswaran (1994), where they assessed participants' attitude towards a new telephone answering machine after being presented with a description for this new product. The authors manipulated the content ambiguity of the description and the source credibility. Specifically, participants read an unambiguous message containing strong or weak arguments, or an ambiguous message containing both strong and weak arguments, regarding the product's attributes. This information was said to been produced either from high credibility source (a magazine specializing in scientific new product testing), or low credibility source (sales staff of a discount store). The results were

consistent with the bias hypothesis, as it was found that when information was ambiguous, participants who were high in motivation and ability to process, information assimilated their attitudes according to the credibility cue. While, for unambiguous messages, only the effect of information strength was found to be influential, which is supported with the attenuation hypothesis of HSM (Bohner et al., 2011).

The ability of a heuristic to bias individuals' systematic processing was also discussed in a study of Zuckerman and Chaiken (1998), where they used the heuristic-systematic model to explore when either systematic or heuristic or both processing modes occur when individuals are presented with products' with warning labels. The authors described how a heuristic can create an expectancy and thereafter how information is interpreted in agreement with this expectancy. They used the text colour of a warning label as an example, and suggested that text colour that implies more serious risks, may lead individuals to interpret information as implying a greater risk. They further supported that the bias effect is most likely to take place when the information on the warning label is ambiguous and thus vulnerable to different interpretations (Zuckerman and Chaiken, 1998).

Gorissen and Weijters (2016), investigated how consumers process information on the environmental impact of food products and how this information can be subject to biased processing. In one of their experiments, the authors found that people rated a hamburger together with an organic apple as having a lower environmental impact compared to the hamburger alone. They attributed this result to the biased effect of the "green product". In a recent study Skubisz (2017) explored the effect of a "natural" claim placed on processed food packages, on product evaluation. The results of this study indicated that even though "natural" claimed products contained the same calories as their regular analogues, participants perceived "natural" products as containing fewer calories. The author argued that "natural" claims were perceived as heuristics used by individuals as a mental shortcut to evaluate the healthfulness of the products (Skubisz, 2017).

In another theory of note, Gawronski and Bodenhausen (2006), in their Associative-Propositional Evaluation (APE) model, distinguish the two following mental

processes of evaluating: the associative process which is activated automatically on encountering an object and is independent of true values, and the propositional process which is based on rational inferences and inputs from the associative source, and is concerned with true values. According to this theory, an associative processing will have a spill over effect to propositional only when the associative outcome is valid and consistent with other relevant propositions. Equally, propositional processes can influence associative processes when a propositional outcome holds a particular salient merit in memory (Bohner et al., 2011, Richetin et al., 2007). Gawronski and Bodenhausen (2007), highlight that the dependency on true values is the property that renders these processes qualitatively different.

DPM's core assumption of two distinct routes of processing was later challenged by Kruglanski and Thompson (1999), who questioned the necessity of two qualitatively distinct routes that dual-process theories support by developing a single-process account, the "Unimodel". According to their criticism the two processes by which information is processed are functionally equivalent and simply differ in the cognitive effort required (Van Overwalle and Siebler, 2005). Unimodel, shares with DPMs the fundamental assumption of the effect of motivation and ability on the process selection, but it "*adopts a more abstract level of analysis*" and treats dual routes as "*special cases of the same underlying process*" (Kruglanski & Thompson, 1999: 84). The Unimodel approach is more in line with the "default-interventionist" categorization of Evans (2008) (Glöckner and Witteman, 2010).

Numerous studies have used these models to explore the role played by intuitive and deliberative processes in attitude formation and change. However, a conceptual problem that was noticed is that most researchers when applying DPMs tend to treat intuition process as a unitary construct (Hogarth, 2010). In recent years, many researchers within social psychological research have stressed the need to identify further useful distinctions within intuition (e.g. (Hogarth, 2010, Gore and Sadler-Smith, 2011, Glöckner and Witteman, 2010, Evans, 2008).

Evans (2008), stated that "*it seems unsustainable to argue that there is just one form of implicit processing*" (p. 258) and argued that the intuitive system is a multiplicity of systems. Stanovich (2012), also noted the wide diversity of processes labelled and

subsumed in the category "intuition", and proposed the term TASS, "The Autonomous Set of Systems" in order to stress that "*they do not belong to a single system with a single set of attributes*" (Evans and Stanovich, 2013).

In a thought-provoking article, Glöckner and Witteman (2010) supported the decomposition of intuition and suggested a "*categorization according to the underlying cognitive processes*", which involves the processes of learning, retrieval and integration (p. 1). Specifically, they proposed the following four different ways of intuitive processing: (a) "associative intuition" which deals with simple learning and retrieval processes such as conditioning and social learning (b) "matching intuition" which involves complex learning of exemplars and prototypes and retrieval processes based on the matching of stimuli to exemplars and prototypes (c) "accumulating intuition" that deals with accumulation of information from memory traces and currently perceived information and (d) "constructive intuition", which moves beyond accumulating processing and suggests that "*information is not only accumulated, retrieved from memory, and matched to exemplars, but mental representations are constructed that go beyond existing information in forming new consistent interpretations*" (p.11).

Dane and Pratt (2012), also argued that there are divergences concerning the nature and functioning of intuitive processes within intuition and provided a classification of three types of intuition: (a) "problem-solving intuition", which in most cases occurs very fast and involves pattern matching of current situations with past experiences (b) "moral intuition" which focuses mainly on ethical dilemmas and also involves a pattern matching process where features of a given scenario are rapidly and automatically compared to prototypes of ethical situations. The difference between "problem-solving" and "moral intuition" is that the latter is often conceptualized as involving more intense emotions and (c) "creative intuition" described as feelings that "*arise when knowledge is combined in novel ways*" (p.5). This type of intuition appears to take longer to arise than either problem-solving or moral intuition.

While previously outlined scholarly work on intuition conceptualized different types of intuition in terms of either intuitive outcome or intuitive process (e.g. Dane &

Pratt, 2009; Glöckner & Witteman, 2010), Gore and Sadler-Smith (2011), provided a new framework which connects both intuitive processes and outcomes. Specifically, they argued that intuition should be conceptualized as a multi-dimensional construct and stressed that intuitive processes need to be distinguished from their outcomes the so-called "intuitions". The authors, quite similar to Dane and Pratt (2012) described four specific types of intuition: "the-problem-solving", "creativity", "moral judgment" and "social judgment" and they further discussed three domain specific intuiting processes evoked automatically on the basis of context specific characteristics: (a) the application of heuristics under conditions of uncertainty (b) the acquisition and activation of complex domain-relevant schemas under conditions of complexity and/or time pressure and (c) the affect infusion under conditions of risk.

The aforementioned theories and models have shown that attitude formation can result from a more intuitive or more deliberative process. The main models of attitude formation have been applied successfully to situations where individuals have some degree of conscious or unconscious experience with the attitude object (Plessner and Czenna, 2011). Nevertheless, there are situations where individuals need to evaluate attitude objects that are unfamiliar or contain some attributes that are unfamiliar. Such cases arise when individuals are asked to evaluate a new food technology or a food product containing a new ingredient. An exploration of the factors and processes influencing attitude formation in this case is the focus of the next section.

4.2.4 Attitude formation towards unfamiliar attitude objects

As discussed earlier, when individuals evaluate familiar attitude objects they use existing knowledge structures, consisting of affective and cognitive information, and form their attitudes either in an intuitive or a deliberative way (Van Overwalle and Siebler, 2005, Edwards, 1990). Individuals are also able to construct attitudes towards unfamiliar attitude objects by creating new connections between the unfamiliar attitude object and existing knowledge structures (Fazio, 2007, Schwarz, 2007).

In real-life context, individuals would have normally been exposed to some attributes of the unfamiliar attitude object and therefore some degree of associations and knowledge should be expected (Loken, 2006). Research has shown that when no established cognitive representations of the stimulus exist, individuals can generate affective evaluations towards the attitude object (Bechara and Damasio, 2005). Affective evaluations usually do not require conscious deliberation, and people can access affect and emotions more easy than cognitive beliefs (Clore and Huntsinger, 2007). Hence, in cases where individuals have limited knowledge and experience with the attitude object, it is more likely that they will rather access affective associations than construct cognitive associations (Van Giesen et al., 2015). This argument can be further supported by research on attitude formation towards relatively unfamiliar attitude objects, such as genetically modified foods and nanotechnology, or in cases when individuals lack specific knowledge towards the attitude object, which has mainly indicated affect as the base for attitude formation (Van Giesen et al., 2015, Lee et al., 2005).

Conner and Armitage (2011), argue that in contrast to attitudes which are firmly "anchored" in knowledge structures, attitudes towards unfamiliar attitudes objects are likely to be based on few associations and therefore be somewhat ambivalent. Specifically, the authors expect that attitudes towards unfamiliar attitude objects are likely to be based on conflicting and inconsistent information and as a consequence of these contradictory statements are ambivalent (Conner and Armitage, 2011). Elsewhere, Jonas et al. (1997) argue that "*Being faced with evaluatively inconsistent information with respect to unfamiliar attitude objects is a ubiquitous state of affairs. Thus, more or less ambivalence regarding such attitude objects or behaviours involving them is a frequent phenomenon*" (p.208).

Attitudinal ambivalence is considered an important topic in research on attitudes with research evidence supporting its connection with information processing (van Harreveld et al., 2014, Yang and Unnava, 2016). The attention given to this topic reflects the increased presence of ambivalence in contemporary society, where huge exposure to information from numerous sources challenges people's attitudes. Especially in the food choice and consumption research area, food behaviour has been associated with ambivalence (Sparks et al., 2001). The next section will

introduce the concept of attitude ambivalence; discuss its different types and delve into the connection of ambivalent attitudes and information processing.

4.2.5 Attitude ambivalence

Attitudes have been traditionally conceived as a unidimensional like–dislike, evaluative construct, with social psychologists usually assuming that attitudinal responses lie along a bipolar continuum ranging from unfavourable to favourable (Jonas et al., 1997). Research on attitude ambivalence suggests that this conceptualisation may be incomplete and there is evidence that individuals may simultaneously hold both negative and positive evaluations, generating the experience of ambivalence (Conner and Armitage, 2011, Jonas et al., 1997, Newby-Clark et al., 2002).

Gardner (1987), defined ambivalence as "*a psychological state in which a person holds mixed feelings (positive and negative) towards some psychological object*" (p. 241). Thompson et al. (1995), conceptualize ambivalence as a state in which an individual "*is inclined to give it [an attitude object] equivalently strong positive or negative evaluations*" (p. 367). Eagly and Chaiken (1993) emphasised the cognitive inconsistency in ambivalence and defined it as "*the extent of beliefs' evaluative dissimilarity (or inconsistency)" (*p. 123). Conner and Armitage (2011), stressed the simultaneous presence of conflicting positive and negative elements within an attitude and described attitudinal ambivalence as *"situations in which attitudes are not polarized and where positive and negative attitudes are expressed simultaneously toward an object*" (p. 261).

In the aforementioned definitions, the reference to the simultaneous existence of positive and negative evaluations and the conflict in evaluation is highly important, as it is this characteristic that distinguish attitudinal ambivalence from attitude uncertainty and variability (Sparks et al., 2001, Conner and Armitage, 2011). van Harreveld et al. (2015), explain how research into ambivalence spawned from the observation that traditional bipolar measures of attitude were unable to distinguish between ambivalence and indifference. He points out that on such bipolar measures, respondents who hold opposing evaluations and those who are indifferent will score

the midpoint of the bipolar scale, nonetheless their evaluations are fundamentally different (van Harreveld et al., 2015). Attitudinal ambivalence is thus not the same as holding a neutral or indifferent attitude toward an attitude object (de Liver et al., 2007, Conner and Armitage, 2011, van Harreveld et al., 2015).

Conner and Armitage (2011), discussed how ambivalence develops and broadly categorized its antecedents into top-down and bottom-up categories. The top-down category includes psychological tendencies and individual differences in personality style that have been linked with holding ambivalent attitudes, such as value conflicts or high need for cognition. The bottom-up category is concerned with features in the environment that can generate ambivalent attitudes, such as the attitude object itself, the existence of conflicting information, overjustification processes, and social norms. Through their review, the authors stated that bottom-up processes are crucial in order to understand attitudinal ambivalence and that they may exert stronger effects than top-down processes (Conner and Armitage, 2011). Their position regarding the rise of attitudinal ambivalence through bottom-up processes aligns with the conceptualization of attitudes as constructed on the spot rather than being stored in memory (Conner and Armitage, 2011).

Delving deeper into ambivalent attitudes, social psychologists have discussed different types of ambivalence. Thompson et al. (1995), described cognitive ambivalence ("*mixed beliefs*"), affective ambivalence ("*torn feelings*") and cognitive/affective ambivalence ("*when your minds tells you one thing, but your heart something else*") (p.378). In the same vein, building on the theory of the existence of attitude's different components of feelings and beliefs, theorists have proposed that ambivalence can exist within these components (intra-component) or between them (inter-component) (Kaplan, 1972, Katz and Hass, 1988). Intra-component ambivalence exists when individuals hold negative and positive beliefs about an attitude object and when they hold positive and negative feelings (Maio et al., 2000). Inter-component ambivalence exits when individuals hold negative beliefs and positive feelings about an attitude object and when they hold positive beliefs and negative feelings about an attitude object (Maio et al., 2000). Intra-component ambivalence has been connected more to psychological tension as people

experiencing inter-component ambivalence may have the ability to distinguish the affective versus the cognitive component of their attitudes and therefore be less bothered by this conflict (Hodson et al., 2001)

Another important notion within the literature of attitude ambivalence, concerns the distinction between *objective* and *subjective* ambivalence. Objective ambivalence refers to the associative structure of ambivalence based on the co-existence of positive and negative associations with regard to an attitude object and subjective ambivalence, also named "felt ambivalence", refers to the extent to which one experiences conflict due to this associative structure (Priester and Petty, 1996, van Harreveld et al., 2015, Newby-Clark et al., 2002). This distinction between *objective* and *subjective* ambivalence reflects the view that the awareness of ambivalence elicits the negative affect produced by it (Newby-Clark et al., 2002). It has been shown that when individuals hold ambivalent attitudes and are asked to make an evaluative choice the discomfort due to ambivalence is enhanced, as in this case individuals try to integrate their conflicting evaluations in one evaluative response, contrary to those who remain uncommitted to a choice (de Liver et al., 2007, Van Harreveld et al., 2009b).

There is ample evidence that ambivalence is an unpleasant experience with many scholars relating ambivalence to the research work on cognitive dissonance (van Harreveld et al., 2015, Van Harreveld et al., 2004). Cognitive Dissonance Theory (Festinger and Carlsmith, 1959), is a motivational theory of how attitudes change to maintain cognitive consistency. This theory suggests that the inner drive to hold attitudes and behaviour in harmony leads individuals to focus on information that confirms their existing attitudes, and ignore contradictory information that potentially opposes their attitude, thereby they becoming more positive and less ambivalent or, equally, more negative and less ambivalent (Bohner et al., 2011, Gawronski and Bodenhausen, 2006, Fischer et al., 2013). While ambivalence shares features with cognitive dissonance it can be conceptually distinguished on a structural level, as "*ambivalence can be understood as an intra-attitudinal discrepancy in contrast to cognitive dissonance, which is generally investigated in the context of discrepancies between attitudes or between attitudes and behaviour*" (van Harreveld et al., 2014). In other words, ambivalence is a pre-decisional

phenomenon, defined by conflict, but often not related to any behavioural commitment, whereas dissonance is usually the result of a behavioural commitment that is in conflict with a pre-existing attitude (van Harreveld et al., 2009a, van Harreveld et al., 2015).

Research has shown that high attitudinal ambivalence reveals increased likelihood of attitude change given the provision of information (Petty et al., 2006, Hodson et al., 2001, Zemborain and Johar, 2007) and that individuals are motivated to reduce ambivalence and its associated negative feelings (Stone and Cooper, 2001, Sawicki et al., 2013, Zemborain and Johar, 2007). The next section explores the relation between attitudinal ambivalence and information processing.

4.2.5.1 Attitudinal ambivalence and information processing

A considerable amount of studies suggest that attitudinal ambivalence exerts a pervasive influence on how people process information (Conner and Armitage, 2011, Schneider et al., 2015). Studies have shown that ambivalence is related to more effort and deliberation in processing of information, as ambivalent attitude holders experience an internal evaluative inconsistency and therefore invest cognitive resources in order to come to a more unequivocal attitude (van Harreveld and van der Pligt, 2004, Van Harreveld et al., 2004). Nordgren et al. (2006), stressed the paradox phenomenon that "*while ambivalent attitudes are themselves considered weak, ambivalence is also said to induce a more effortful processing*" (p.253). Drawing on cognitive dissonance theory the authors argued that the unpleasant experience of ambivalence motivates ambivalent people to process any information that might help them to resolve their conflict (Nordgren et al., 2006).

Jonas et al. (1997) argued that processing information about new or unfamiliar attitude objects with evaluative inconsistent aspects leads to attitudinal ambivalence. Moreover, they claimed that the mediating mechanisms for the effects of ambivalence on information processing is the confidence one has in one's attitude. Specifically, they showed that ambivalent respondents are more likely to engage in systematic processing because they hold their attitude with less certainty. The authors further argued that in cases where individuals have to form attitudes for a

new or unfamiliar attitude object, the evaluative inconsistency between the diverse attributes of the attitude object is highly salient (in comparison with attitudes towards objects where existing attitudes can be accessed) and that may also lead to increased systematic processing of the attitude object's attributes.

In a study on attitudes toward minorities, Maio et al. (1996) showed that ambivalent respondents are more likely to engage in systematic processing of information about the minority group and they actively seek and use information in order to resolve their ambivalence. In their study, participants possessing ambivalent attitudes engaged in more extensive processing of the persuasive message than did participants who held relatively unambivalent attitudes. The authors states that ambivalent respondents are more likely to engage in systematic processing because they are motivated to reduce their ambivalence (Maio et al., 1996). In another study, Van Harreveld et al. (2004), found that ambivalent individuals tend to select more attributes as important for their evaluations and need longer time to integrate the evaluatively incongruent attributes (positive and negative cognitions) into an overall attitude, than individuals who integrate only univalent cognitions. The authors also supported that it is likely for individuals encountering an attitude object for the first time to go through bottom-up information processing to derive their overall attitudes, whereas when encountering it again, it a top-down attitudinal response should be expected.

The studies presented above, illustrate how ambivalence can be potentially reduced through effortful processing and weighing of all alternatives. This strategy is termed as unbiased systematic processing (Van Harreveld et al., 2009b). However, there are cases where thinking about ambivalent issues extensively can increase ambivalence even further (Clark et al., 2008). In these cases, in an effort to avoid thinking about controversial persuasive messages, individuals may engage in biased systematic processing (Van Harreveld et al., 2009b).

The relation between ambivalence and biased information processing was identified in a study by Clark et al. (2008), which showed that ambivalent attitude holders have been found to elaborate more on pro-attitudinal (agreeable) messages and avoid counter-attitudinal (disagreeable) messages. In a similar vein, Nordgren et al. (2006),

also proposed that ambivalence can be resolved through biased information processing. The authors provided evidence that ambivalent individuals used any (slight) positive or negative inclination in order to select elaboration of information in accordance with their prior attitudes.

In a study of health behaviours, Broemer (2002) found that ambivalence produces a bias toward preferring negative information. The authors showed that ambivalent individuals exhibited greater attitude change when confronted with negatively framed persuasive messages, whereas non-ambivalent individuals were more persuaded by positively framed messages. In a more recent study, Yang and Unnava (2016), investigated the effect of ambivalence on the type of information that individuals seek and choose and how this choice subsequently affects their state of ambivalence. The results revealed that the negativity bias was not dominant for all ambivalent individuals, but only for those for whom the negative information served to reduce their ambivalence.

Sawicki et al. (2013), delved deeper into the effect of ambivalence on information seeking by stressing the role of knowledge about the ambivalent attitude object. In that study, ambivalent attitudes yielded strong preference for selective exposure to pro-attitudinal information when individuals lacked knowledge about the attitude issue. The authors stressed the significant role of information familiarity in reducing ambivalence and showed that unfamiliar attitude-consistent information was perceived more effective (in comparison with known pro-attitudinal information) in resolving the tension of ambivalent state. In contrary, when ambivalent individuals were more knowledgeable on the attitude issue, preference for attitude congruent information disappeared, and familiar information was perceived relatively ineffective in reducing ambivalence. The results of that study share similarities with Jonas et al. (2000) arguments that ambivalent attitude may less likely change in response to persuasion, since the information provided by the persuasive message may already be part of the knowledge base of the ambivalent attitude and have proven unconvincing.

Besides unbiased or biased information processing, studies have shown that specific heuristics can be used in effective ways in order to resolve ambivalence. For example, Hodson et al. (2001), investigated how attitudinal ambivalence towards a political issue (social welfare) moderates the impact of consensus information on attitudes subsequently expressed. The authors found that ambivalent attitude holders were persuaded by consensus information (knowledge of others' attitudes) while low ambivalence participants did not comply with the consensus information (Hodson et al., 2001). In another study, Zemborain and Johar (2007), found that during evaluation judgment formation, ambivalent individuals were less critical in examining the reliability of information source and agreed with the message regardless of the reliability. These results indicate that during the process of attitude formation where knowledge is limited and motivation to make a choice is high, heuristic processing could be an efficient way to reduce conflict created by ambivalence (Imbir, 2017).

In conclusion to this section, a number of studies suggest that the motivation to reduce the unpleasant experience of attitudinal ambivalence can lead to (biased or unbiased) systematic or heuristic information processing. In most of the studies presented earlier, information provision was manipulated in terms of selectivity exposure, one-sided message, balanced message, number of attributes and familiarity. The next section will focus on situations where individuals are confronted with ambiguous information.

4.2.5.2 Attitude formation under conditions of ambiguous information

In a social context, people's evaluative judgments involve the evaluation of ambiguous and univocal information. Especially in the cases of new or unfamiliar attitude objects, individuals are intentionally or unintentionally exposed to an ambiguous mixture of both favourable and unfavourable arguments. For example, previous research on consumers' attitudes towards new technologies and food products derived from them, has tried to investigate the effect of ambiguous information on people's attitudes (e.g. Fischer et al., 2013, Van Dijk et al., 2012).

Jonas et al. (2000), refer to ambiguous information as "*information that contains evaluatively inconsistent aspects with respect to the object*" (p.57). Studies that employed ambiguous messages used a mixture of favourable and unfavourable arguments (e.g. Chaiken and Maheswaran, 1994, Bohner et al., 2002). Theoretically ambiguous message provision has been connected with biased information processing (Conner and Armitage, 2011). Conner and Armitage (2011) describe why biased processing should be expected when individuals process ambiguous information. The authors explain that when favourable and unfavourable arguments are provided, they activate the positive and negative response components and further the overall evaluative judgment. However, as both positive and negative components are activated, they cancel their effect on the overall attitude judgment. Therefore, ambiguous message results in null effect and attitude formation should be determined by the positive or negative valence of the heuristic cue alone.

Ziegler et al. (2007) used the classic functional approaches to attitudes (e.g. Katz's functionalist theory discussed earlier) and found that persuasive arguments matching the functional basis of individuals' attitudes may lead to biased processing given that the message is ambiguous. Specifically, the authors presented low and high self-monitors with matched or mismatched messages, having strong, weak or ambiguous content. The study revealed that when the ambiguous message matched the function of the attitude, biased processing led to more agreement. In contarst, no evidence was found for biased processing in the case of unambiguous messages. Strong unambiguous messages led to more agreement (than weak) regardless of functional matching, revealing unbiased processing.

Turning to more recent research papers, in the study by Fischer et al. (2013), participants were provided with different risk-benefit information; either one sided information (i.e. only risk or only benefit) or balanced information (i.e. both risk and benefit) on nanotechnology applications in food production. The authors found that one-sided information influenced attitudes towards the direction of the information (i.e. benefit information resulted in more positive attitudes and risk information resulted in more negative information). Contrary, the provision of balanced risk-benefit information resulted in some individuals becoming more positive and less ambivalent while others became more negative and less ambivalent towards nano-

foods. Interestingly, a third large group maintained a neutral attitude and became more ambivalent. Fischer et al. (2013), argued that individuals who became less ambivalent after receiving risk-benefit information, actively discard part of the information and adopted only one side of the information. Regarding the group of individuals who became even more ambivalent the authors argued that they seem to accept high levels of uncertainty in their attitudes and they may postpone their decision until "trusted others" express their positions.

In another study, Van Dijk et al. (2012) examined the role of initial attitudes on the impact of one-sided versus balanced positive and negative information on post-information attitudes towards different food production methods. The study revealed that the impact of balanced information on post-information attitudes was dependent on initial attitudes. Specifically, the risk information had a dominant effect on post information attitudes for individuals with positive initial attitudes, whereas benefit information had a dominant influence for people with initial negative attitudes. The authors interpreted these results in accordance with the negativity bias and supported that it was attitude-incongruent information and not attitude- congruent information that was used more in the formation of post-information attitudes.

To sum up, reflecting on the studies presented above, it becomes apparent that research on attitude formation should investigate the effect of information that contains both positive and negative information. Providing negative and positive information may affect people differently depending on their level of ambivalence and availability of heuristic cues.

4.3 Conclusion

The purpose of this chapter was to provide an explanation of how attitudes form. Drawing on literature within the area of social sciences, several concepts relating to attitude formation and information processing were discussed. The concepts of attitude components and formation processes have been explored, with literature illustrating that attitudes may be jointly guided by affect and cognition, while formation process can be deliberate and/or intuitive.

Moreover, many authors within the area of social psychology define attitudes as relatively stable entities formed based on associations and evaluations stored in memory, while others define them as being relatively unstable, and focus on the temporary constructions guiding their formation (Bohner & Dickel, 2011). This thesis aligns with Bohner and Dickel (2011) and Van Kleef et al. (2015) perspective that attitudes should be conceptualized as flexible and situational constructed based on a combination of stored representations of an attitude object and information that is currently available.

Information provision received a significant attention in the literature reviewed on attitudes. This review suggests that the effect of information on attitudes should be studied by exploring the influence of information on attitude formation process and attitude components. This chapter has also provided an overview of how attitudes towards unfamiliar attitude objects form, stressing the presence of ambivalence due to conflicting and inconsistent information. The concept of attitude ambivalence and its relationship with information processing was explored illustrating that individuals are motivated to reduce attitude ambivalence, processing is more effortful where there are high levels of ambivalence.

The exploration of literature in this chapter has provided a fruitful bridging of the different schools of thought, by providing links and associations between existing theories in the areas of social psychology and food research. Explicitly, this review has enabled an understanding of the relevant theories that can be applied in order to provide the theoretical foundations to analyse consumers' attitudes on incorporating protein extracted from beef offal into food products.

The next chapter presents the research design and methodology applied in this study by linking the theory to the research aim of this study. The methodological approach addresses relevant concepts from the literature review on attitude formation and information processing.

5 Methodology

5.1 Introduction

The purpose of this chapter is to provide an overview of the activities undertaken in order to address the research questions of the study. The first section restates the overall research question and objectives of the study. The next section provides an overview of the methodological considerations that informed the experimental design, including the choice of positivist as the paradigm grounding this research and a description and justification of the quantitative approach undertaken. The following section discusses the theoretical framework which incorporates relevant theories from the extensive literature review presented in the previous chapter on attitude formation and information processing procedures. Following this, a set of hypotheses are presented, along with the development of the research analytical framework. The chapter continues with an extensive section on the quantitative research design for this study, which includes the description and justification of study manipulations, the recruitment of the study participants and the choice of the measurements used in the survey. Following this, a description of the survey procedure is provided and the chapter concludes with an overview of the data analysis methods used to assess the results of the consumer survey.

5.2 Addressing the research question and research objectives

The most suitable research design and method of data collection depends on how best to address the specified research questions. The overall objective of this study was to explore Irish consumers' attitudes on incorporating protein extracted from beef offal into food products. As outlined in Chapter 1, this research addresses the following core question:

What attitude processes dominate attitude formation towards food products containing protein extracted from beef offal and are the resulting attitudes more affective or cognitive in nature?

Additional research questions, deriving from this core question, were as follow:

- *Are attitudes towards food products containing protein extracted from beef offal influenced by affect and/or cognition?*

- *In terms of underlying processes, to what extent can attitudes towards food products containing protein extracted from beef offal be predicted by intuitive and/or deliberate evaluations?*
- *Does information influence attitudes towards food products containing protein extracted from beef offal?*
- *Does product familiarity influence attitudes towards food products containing protein extracted from beef offal?*

5.3 Research design

Yin (1994) defines a research design as "*the logic that links the data to be collected to the initial questions of study*" (p. 18). The research design concerns the overall plan of how the research questions will be answered and how the research is conducted; and it involves choices regarding methods and techniques, analysis and interpretation of findings (Saunders, 2009). In terms of the research design process choices made for this study, the chosen paradigm is positivist and the research methodology applied is quantitative, involving a population-based survey experiment. An overview and justification of each aspect of the research design process follows.

5.3.1 Research paradigm

Research paradigms were first considered by Kuhn (1962) in his revolutionary work "The Structure of Scientific Revolutions" where he defined a research paradigm as sets of beliefs that provide theoretical frameworks for the purpose and conduction of research. It is concerned with which research philosophy, approach and strategy the study undertakes (Saunders, 2009). Burke (2007) states that "*The research paradigm, once chosen, acts as a "set of lenses" for the researcher – it allows the researcher to view the fieldwork within a particular set of established assumptions, thus merging the abstract usefulness of the paradigm with the practical application of conducting rigorous research*". This "set of lenses" is probably the reason why Guba and Lincoln (1998) stress the importance of establishing and stating the philosophical paradigm at the outset when engaging in an investigation in all forms of research.

Two important research paradigms were considered in this study: positivist and interpretivist (Merriam, 2013, Saunders, 2009). Positivist is concerned with research on social reality where the results can be generalised (Saunders, 2009, Burke, 2007). It refers "*to the search for explanations of social phenomena, from the view of a realist...It is a logical, rational view which is often "problem orientated in approach". It has its roots in the pure sciences where issues could be measured, evaluated and monitored*" (Burke, 2007). Interpretivist is concerned with understanding the world and each situation, dependent on the tangible and intangible variables that are present at the time (Saunders, 2009). Interpretivism "*assumes no single, observable reality*" and builds on the premise that reality is subjective and socially constructed (Merriam, 2013).

In terms of research paradigm, this research is grounded in the positivist perspective. In the positivist approach, the emphasis is on a highly structured methodology and research is conducted by identifying a clear research topic and constructing appropriate hypotheses (Saunders, 2009). Due to the specificity with which the research questions were formulated, the positivist approach was adopted in order to address the aims of the study. The following section moves the focus from research paradigm to methodological approaches.

5.3.2 Justification of quantitative approach

The research paradigm is not concerned with a researcher's choice to adopt qualitative or quantitative research methods (Saunders, 2009). However, as soon as it is decided it implicitly determines the most appropriate methodological strategy. In fact, positivist, the paradigm with which this study is aligned, is grounded in quantitative research (Merriam, 2013), as it builds on the premise that *"facts are clearly defined and results are measurable"* (Burke, 2007).

Salmon (2003) posits that "*whether to be quantitative or qualitative in any specific study should be decided by 'fit' with the phenomenon being studied*" (p. 25). A quantitative research strategy was chosen in this research, due to its focus on testing developed theories and predicting behaviours (Merriam, 2013). Based on the extensive literature review undertaken, the focus in this research is on testing

hypotheses and investigating specific cause effect relationships. The use of a qualitative research strategy would have been in contrast to this, where the focus would have been on collecting and providing the meanings and descriptive understanding of phenomena in non-numeric form (Saunders, 2009). Hence, a quantitative approach was deemed more suitable for this work, in the context of meeting the research aims and addressing the research question posed. Following the selection of the research method, a decision on the appropriate quantitative research technique needed to be made.

Quantitative research methods involve different kinds of techniques and can include surveys, experiments and quasi-experiments (Merriam, 2013). In this study, the experimental design was applied in order to enable the study of causal relationships among variables; whether a change in one independent variable produces a change in another dependent variable (Hakim, 2000). Experimental designs in social sciences can be classified in three classes: laboratory, field and population-based survey experiment (Jackson and Cox, 2013). Field experiments are distinguished from laboratory experiments by the fact that the former take place in a real-world context (Jackson and Cox, 2013). Mutz (2011) defines a population-based survey experiment as " *[A] population-based survey experiment is an experiment that is administered to a representative population sample… [It] uses survey sampling methods to produce a collection of experimental subjects that is representative of the target population of interest for a particular theory*." (p.2). An online population-based survey experiment was chosen for this study as it is appropriate for testing causal hypotheses while at the same time offers a high degree of external validity (i.e. the experiments are carried out on a representative sample of people), coupled with high degree of internal validity (i.e. substantial control over experimental conditions) (Jackson and Cox, 2013). Previous research has identified drawbacks and benefits associated with online surveys. Starting with the benefits, online surveys offer access to large and diverse samples, in a cost- and time-effective manner (Birnbaum, 2004; Reips, 2002). Moreover, online surveys support flexible and complex designs (e.g. more than one type of response format, skip patterns etc.) which provide automation in data input, handling and analysis. On the other hand, online surveys are plagued by problems such as data quality, high rates of incomplete forms, and the possibility of repeated participation (Birnbaum, 2004;

Reips, 2002). Lack of understanding and attention in instructions or/and distracting and noisy environments might reduce data quality (Kraut et al., 2004). Researchers have suggested some actions in order to reduce incomplete survey forms and repeated participation. For example, repeated participation by a person in the same survey, can be addressed by rejecting any data from the same IP address (Kraut et al., 2004; Reips, 2002), while incomplete surveys can be reduced by careful programming which does not allow the progress of a survey if it contains blank answers.

Having outlined and justified the research approach undertaken, the following section presents the theoretical framework that will inform the development of the research analytical framework to address the research questions of this study. Drawing upon the extensive literature review presented in Chapter 4 on attitude formation and information processing, and the other related constructs, the next section describes how selected theories and concepts explain the research questions posed in this study.

5.4 Theoretical framework

In the theory chapter (see section 4.2.2) it was discussed that attitudes can stem from affective reactions that people experience when they encounter the attitude object and/or from cognitive beliefs that are attached to the attitude object (Fazio, 2007). In attitude research, a distinction is usually made between overall attitudes and affective and cognitive attitudes, allowing the identification of the relative importance of affect and cognition on overall attitudes (Pham, 2007, L. Jr. Crites et al., 1994). In addition, two types of evaluation processes were discussed, the intuitive and the deliberate. Intuitive evaluations have been described as unintentional, immediate, stimulus-based, effortless, and can involve emotional based judgments based on quick intuitions such as "gut" feelings (Duckworth et al., 2002, Pachur and Spaar, 2015, Haidt, 2001). Individuals can evaluate both new and familiar attitude objects based on these intuitive evaluations, without necessarily relying on extensive cognitive processes (Duckworth et al., 2002). On the other hand, deliberate evaluation arise from conscious and thoughtful consideration of stimuli information

(Olson and Kendrick, 2011). This more deliberate evaluation may produce other thoughts and potentially override the response of the intuitive evaluation. As discussed in the previous chapter, the notion that both types are active and interact during attitude formation has been empirically supported by Dual-Processing Models (DPMs). To summarise, attitude formation can be the result of a more intuitive or deliberate process, whereas the attitude outcome can have a more affective or cognitive base (van Giesen, 2015) (see Fig. 5.1).

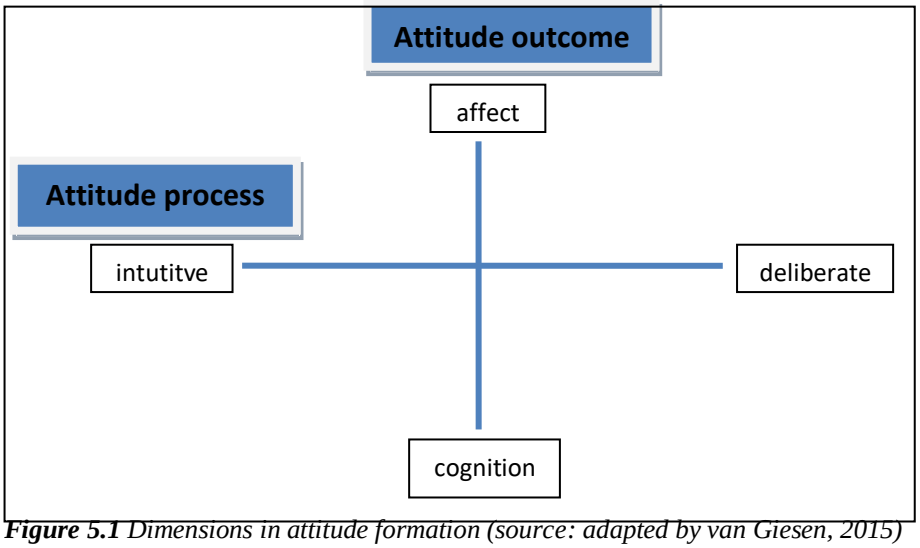


Figure 5.1 *Dimensions in attitude formation (source: adapted by van Giesen, 2015)*

In the current study, both attitude outcomes and attitude process measures will be used in order to investigate both dimensions of attitude formation and their interplay. Attitude measures will be used to understand if attitudes towards food products containing protein extracted from beef offal are based more on affect or cognition, and attitude underlying processes measures will be used to explore their effect and predictive power on overall attitudes towards food product containing protein extracted from beef offal.

In addition, in the theory chapter (see section 4.2.3) it was emphasized that attitude formation is highly related to information provision and processing (Crano and Prislin, 2006, Eagly and Chaiken, 2007) as attitudes can be formed (or altered) as a result of received information (McCarthy et al., 2003). In this thesis, the role of information provision on overall attitudes towards food products containing protein extracted from beef offal will be investigated.

Health-related information is increasingly used for food products' marketing and research has shown that it affects consumers' responses to foods in general, and to unfamiliar or novel foods in particular (Lampila et al., 2009, Leathwood et al., 2007, Lähteenmäki, 2013). Research on functional foods for example has shown that consumers are more willing to accept them if information on health benefits is provided (Siegrist et al., 2008, Lalor et al., 2011). In a study on consumer acceptance of unfamiliar açaí fruit juices, Sabbe et al. (2009) demonstrated that health information leads to an increase in overall liking for these unfamiliar fruit juices. Besides or along with the effect of health benefits information on consumer acceptance of new or unfamiliar foods, the effect of information on environmental benefits has been also studied. In a recent study, Barsics et al. (2017) showed that information on insect-based foods encompassing ecological, health, and gastronomic aspects could change consumers' attitudes and acceptability of novel insect-based food samples. In a similar vein, Verneau et al. (2016) investigated the effect of benefit communication on insect consumption and showed that providing information about the individual (i.e. human health) and social benefits (i.e. environmental benefits) of eating insects raised people's intention to eat insect-based food.

However, while providing information on health and environmental benefits to consumers is a common strategy, not all consumers are health conscious or interested in or aware of the environmental impacts of their food choices (Chkanikova and Mont, 2015). For example, in a study by McFarlane and Pliner (1997), the authors found that only those people who were interested in nutrition and health indicated a higher willingness to eat novel foods after receiving health information. Thus, it is expected that when individuals hold food choice motives around the environment and health, information provision on health and environment benefits of food products containing protein extracted from beef offal will have a greater effect on attitudes towards these products

As was discussed in the previous chapter (see section 4.2.5.1), consumers are often confronted with contradicting arguments regarding products attributes and/or benefits. Insufficient or contradictory information leads to the ambivalence that characterises public reactions to new foods (Grunert et al., 2001, Bäckström et al.,

2003). This ambiguity that characterises attitudes towards new or unfamiliar food products will be also addressed in this study by providing ambiguous health-related and environment-related information. Thus, manipulations in information provision –no information/benefit information/ambiguous information[9]- will be used in order to explore the role of information provision on individuals' attitudes towards food products containing protein extracted from beef offal.

Finally, in the theory chapter (see section 4.2.4), it was discussed that the evaluation process and the effect of affect and cognition on overall attitude differ depending on individual's familiarity with the attitude object. Previous empirical research (e.g. Fischer and Frewer, 2009, Wansink, 2002, Gmuer et al., 2016) has shown that familiarity has an important role in introducing new foods and should not be neglected. For example, research on insects as food has repeatedly shown that insects are likely to be more acceptable when they are incorporated into familiar foods (Gmuer et al., 2016, Tan et al., 2016, Tan et al., 2015, Schösler et al., 2012). Some researchers have also suggested that incorporation of insects and offal into convenience foods such as burger patties and sausage might be one of the most acceptable ways to encourage consumer acceptance (Schösler et al., 2012, Verbeke, 2015, Wansink, 2002). Thus, manipulations in product familiarity -familiar versus unfamiliar food products- will be used in order to explore the role of product familiarity on individuals' attitudes towards food products containing protein extracted from beef offal.

Having presented the theoretical framework of this study, the next section moves to the development of the research analytical framework. A set of hypotheses was put forward along with the proposed analytical frameworks.

5.5 Research analytical frameworks and hypotheses

Based on the above-mentioned theories, and drawing from de Beukelaar et al. (2019) research paper, a research analytical framework was developed (Fig. 5.2) in order to

[9] Provision of negative information was not deemed relevant manipulation in this study. Negative information in the context of the current study would relate to risk psychology research, including concepts of risk perception, risk aversion and others, which are beyond the scope of this study.

test the relationships among attitude formation processes and overall attitude, under different conditions of familiarity and information provision. In this framework, "*familiar vs unfamiliar product concepts*" and "*information provision*" represent two categorical independent variables. Food products containing protein extracted from beef offal can either be "familiar" or "unfamiliar" and information about protein derived from beef offal as human food can either be "benefit information", "ambiguous information" or "no information". These two variables (i.e. "*familiar vs unfamiliar product concepts*" and "*information provision*") inform individuals' overall attitudes towards food products containing protein extracted from beef offal through intuitive evaluation processes and deliberate evaluation processes. It is expected that familiarity with the food product concept mostly influences the intuitive evaluation process, while the role of information provision is more important in deliberate evaluation processes (de Beukelaar et al., 2019).

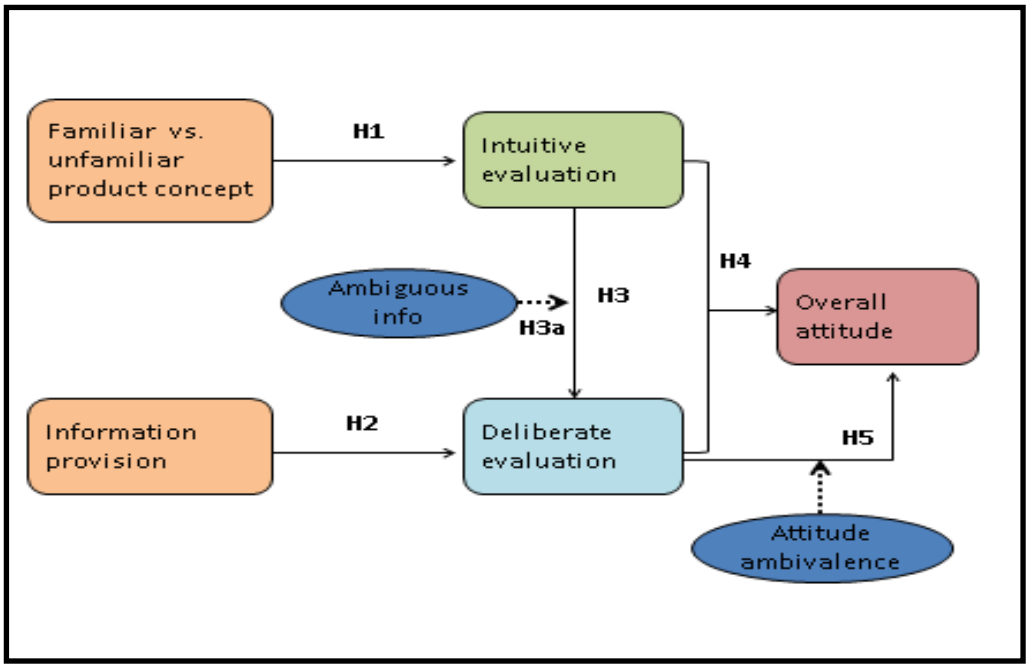


Figure 5.2 *Proposed research analytical framework relating attitude formation processes to overall attitudes towards food products containing protein extracted from beef offal*

H1: Individuals who are exposed to an image of a familiar product concept are more likely to have more positive intuitive evaluation than people who are exposed to unfamiliar product concepts.

H2: Individuals who are provided with either benefit or ambiguous information are more likely to have a more positive deliberate evaluation of product concepts

containing protein extracted from beef offal than people who are provided with no information.

H3: The more positive the intuitive evaluation the more positive the deliberate evaluation will be.

H3a: For individuals who are exposed to ambiguous information, it is more likely that their deliberate evaluation will be determined by intuitive evaluation in accordance with HSM's bias hypothesis.

H4: The more positive the intuitive and deliberative evaluations are, the more positive the overall attitude will be.

H5: The more ambivalent the attitudes, the greater will be the effect of deliberate evaluation on overall attitudes.

Moreover, a second model (Fig. 5.3) was developed in order to test the relationships between attitude components and overall attitudes towards food products containing protein extracted from beef offal, under different conditions of familiarity and information provision.

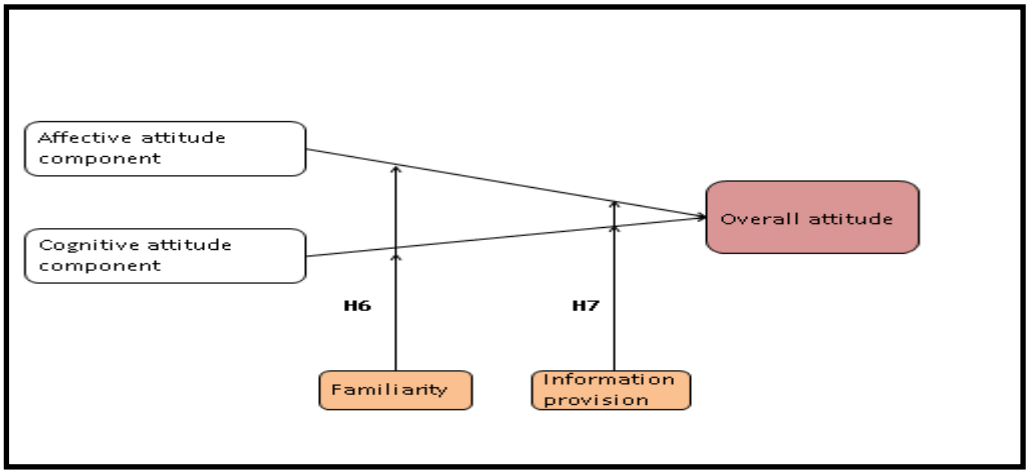


Figure 5.3 *Proposed research analytical framework relating attitude components to overall attitudes towards food products containing protein extracted from beef offal*

H6: Affect will have a relatively stronger effect on overall attitude for unfamiliar compared to familiar product concepts, whereas cognition will have a weaker effect on overall attitude for unfamiliar than for familiar product concepts.

H7: Cognition will have a relatively stronger effect on overall attitude for individuals provided with either benefit or ambiguous information compared to individuals

provided with no information, whereas affect will have a stronger effect on overall attitude for individuals provided with no information compared to individuals provided with either benefit or ambiguous information.

5.6 Method

This section starts with a description and justification of study manipulation decisions undertaken in this research in order to address the research questions. These decisions involved product concepts selection, in terms of product carrier and beef offal protein source and information provision conditions. Following this, the experimental design and the recruitment of participants are described. Finally, the measures used in the consumer survey are detailed. All the attitudinal scales used were drawn from previously published academic literature.

5.6.1 Manipulations

Carrier product selection

Previous research on consumer attitudes towards new and novel foods, such as functional foods and insects, has stressed the important role of perceived fit of carrier-ingredient combination on acceptability (e.g Krutulyte et al., 2011, Tan et al., 2017, Tan et al., 2015, Bech-Larsen and Grunert, 2003, Lu, 2015, Van Kleef et al., 2005, Lyly et al., 2007, Verbeke et al., 2009). For example, Tan et al. (2015) found that grasshoppers were perceived as appropriate with chili and salt but inappropriate with chocolate due to perceived sensory mismatch and/or due to a perceived role of insects as meat substitutes. Also, in a consumer study on functional foods, Ares and Gámbaro (2007) concluded that the carrier product had the greatest effect on consumers' willingness to try different functional food concepts.

Without neglecting the crucial role that the carrier product type plays, in this study the carrier effect was removed by choosing carrier products that conceptually represent an appropriate carrier-ingredient combination. In this way, the compatibility between ingredient and carrier, (i.e. offal extracted ingredients incorporated in meat based products) allowed us to study the effect of the other factors of interest. Sausages and burgers were the carrier food products chosen to

serve this scope. Given that these products are commonly prepared with collagen or intestine casings and red offal, it is expected that ideationally it is not incongruent to add ingredients extracted from offal in these products, as opposed to a product characterised by totally different properties (e.g. coffee). Furthermore, this choice was also reinforced by the review undertaken in Chapter 2 (see section 2.4.1) where most recommendations concerning the applications of offal extracted protein for the food industry, were targeting processed meat products. Finally, in accordance with the study by de Beukelaar et al. (2019), it was decided to include two different food product concepts in order to control for individual differences in liking for the specific food products and also to serve as internal replication for the study.

Selection of protein source

As discussed earlier and more extensively in the previous chapter (see section 4.2.4), familiarity with the attitude object influences individuals' attitude formation and the effect of cognitive and affective attitude component on overall attitudes. Manipulations in familiarity with the product concepts containing protein extracted from beef offal (i.e. familiar versus unfamiliar) were applied in this study in order to address the role of individuals' perceived familiarity with the product concepts in influencing their attitudes towards these products.

The selection of the familiar and unfamiliar product concepts containing protein extracted from beef offal was based on a pre-test conducted with 26 Irish consumers, during an event called "Science week" which took place in Teagasc, Ashtown Food Research Centre. This open-to-the-public event, celebrates science in everyday life, and offers the general public the opportunity to participate in workshops, talks, laboratory demonstrations, science walks and other science-related events. Visitors of this event were approached and asked to fill in a short questionnaire (questionnaire used in this pre-test can be found in Appendix II). The participants reported their familiarity with burgers and sausages containing protein extracted from six different beef offal sources: heart, blood, liver, lung, bone and skin. The selection of these sources is based on the review undertaken in Chapter 2 (see section 2.4.1) regarding the most promising sources for exploration for the food industry. Familiarity with these product concepts was measured using a five-point scale (1-not

known as food, 2-known as food but never tasted, 3-tasted before, 4-eat occasionally, 5-eat regularly) according to Tuorila et al. (2001).

Based on reported high and low levels of familiarity (see Table 5.1), the following choices regarding the familiar and unfamiliar product concepts were made:

- familiar products consisted of "*burger containing protein extracted from beef liver"* and *"sausages containing protein extracted from beef liver"*
- unfamiliar products consisted of "*burger containing protein extracted from beef lung"* and *"sausages containing protein extracted from beef lung".*

Table 5.1 *Means for familiarity with burgers and sausages containing added protein extracted from 6 different beef offal sources (n=26) (measured on 5-point scale)*

	Burger containing added protein extracted from:					
	Liver	Blood	Heart	Lung	Bone	Skin
Familiarity (M)	2.08	2.04	1.88	1.69	1.65	1.62
	Sausages containing added protein extracted from:					
	Liver	Blood	Heart	Lung	Bone	Skin
Familiarity (M)	1.92	2.00	1.92	1.50	1.54	1.69

Information provision manipulation

Manipulations in information provision (no information/benefit information/ambiguous information) were used in order to explore the role of information provision in the process of attitude formation. More specifically, participants in all conditions were informed that the presented food products contained protein extracted from beef liver/lung. In the "Benefit information" condition, an extensive information text was given to participants about the health and environmental benefits of protein extracted from beef liver/lung for human consumption. In the "Ambiguous Information" condition, a more extensive text was given to participants containing ambiguous arguments regarding the health and environmental benefits of protein extracted from beef liver/lung for human consumption.

To validate that the two information texts differ in terms of arguments' strength and valence, a pre-test was conducted with 29 Irish students. Following personal communication by the research team with a professor based in University College Dublin, access was allowed to an undergraduate class. Participants received either the benefit or the ambiguous information text and were asked to evaluate the strength and the valence of the arguments presented in the information. Strength of these arguments was measured using a three-item, seven-point scale (very weak-very strong, not very convincing-very convincing, not very powerful-very powerful) in accordance with Gürhan-Canli and Maheswaran (2000) and Gürhan-Canli and Batra (2004) (reported Cronbach's alpha .83 and 9.2 respectively). Valence of given information was measured with a single item, seven-point scale (very negative- very positive) (questionnaires used in this pre-test can be found in Appendix III).

The text providing "*benefit information"* (*M*=5.66, *SD*= 0.81) was perceived to have more positive valence by the students in the pre-test than the "*ambiguous information*" text (*M*=4.71, *SD*= 1.06). One-way Anova revealed that this difference is statistically significant (F =(1,27) = 7.33, p = .01). The strength of arguments in the "*benefit information"* text (*M* = 4.88, *SD*= 0.95) was found to be higher than in the "*ambiguous information"* text (*M*=4.16, *SD*= 1.00). One-way Anova showed that this difference is statistically significant (F (1,27) = 3.942, p = .05).

It should be noted here that literature suggests that the impact of information provision on consumers' attitudes is strongly affected by perceived credibility and trustworthiness of the information source (e.g. Henchion et al., 2016, Cash et al., 2015, Gray et al., 2005, Costa-Font et al., 2008, Frewer et al., 2003) and especially in those situations where attitudes have not yet crystallised (Frewer et al., 1998). In this study, the source of the information was intentionally unspecified in order to minimize the potential effect of information source credibility on participants' expressed attitudes.

5.6.2 The experimental design and recruitment of participants

Experimental design

In a 2x3 between-subject design, participants were randomly assigned to one of the six possible study conditions (see Table 5.2). The conditions differed according to the two factors: product concept familiarity (2-level: familiar, unfamiliar) and provision of information (3-level: no information provided, benefit information provided, ambiguous information provided).

Specifically, the study manipulations consisted of exposing participants to two pairs of images, each showing a food product (burger and sausages) with the text "*This burger/these sausages contain(s) protein extracted from beef liver/lung*". In the "benefit information" condition, participants were provided with benefit information about the health and environmental benefits of protein extracted from beef liver/lung for human consumption. In the "ambiguous information" condition, ambiguous information containing balanced benefit and negative information regarding the consumption of protein extracted from beef liver/lung was provided.

Table 5.2 *The two stimuli in each of the six study conditions*

Factor: Product familiarity		Familiar (protein extracted from beef **liver**)	Unfamiliar (protein extracted from beef **lung**)
Factor: Information provision	Not provided	 This burger contains protein extracted from beef liver  These sausages contain protein extracted from beef liver	 This burger contains protein extracted from beef lung  These sausages contain protein extracted from beef lung
	Benefit info provided	 This burger contains protein extracted from beef liver. Protein extracted from beef liver has a high health value and is environmental friendly.  These sausages contain protein extracted from beef liver. Protein extracted from beef liver has a high health value and is environmental friendly.	 This burger contains protein extracted from beef lung. Protein extracted from beef lung has a high health value and is environmental friendly.  These sausages protein extracted from beef lung. Protein extracted from beef lung has a high health value and is environmental friendly.
	Ambiguous info provided	 This burger contains protein extracted from beef liver. Protein extracted from beef liver has a high health value and is environmental friendly. However, when improperly treated, protein extracted from beef liver does not supply any health value and can have a negative environmental impact.  These sausages contain protein extracted from beef liver. Protein extracted from beef liver has a high health value and is environmental friendly. However, when improperly treated, protein extracted from beef liver does not supply any health value and can have a negative environmental impact.	 This burger contains protein extracted from beef lung. Protein extracted from beef lung has a high health value and is environmental friendly. However, when improperly treated, protein extracted from lung does not supply any health value and can have a negative environmental impact.  These sausages contain protein extracted from beef lung. Protein extracted from beef lung has a high health value and is environmental friendly. However, when improperly treated, protein extracted from beef lung does not supply any health value and can have a negative environmental impact.

Recruitment of participants

To achieve the research goal and based on previous works that undertook representative surveys in the island of Ireland (e.g. de Boer et al., 2004, Brennan et al., 2007, Ryan et al., 2004) a total sample of 1,020 was specified. Furthermore, this number allowed comparative analysis and inferences to be made, while assured a representative sample with a confidence level of 96% and margin of error of 3%.

Recruitment of participants and administration of the questionnaire was undertaken by a reputable field market research agency following a competitive tendering process. By utilising a wide range of online and offline recruitment channels, the market research agency ensured a diverse profile of individuals. Initially, the market research agency randomly invited individuals from its sample sources by an email. To avoid self-selection bias, specific project details were not included in the email invitation. Instead, individuals were invited to complete a survey with general survey details i.e. survey theme, length of survey.

Once the survey was in field, quota controls were applied in terms of age, gender, education, social class and geographical area to ensure a representative sample of the Irish adult population. Individuals were not recruited if they were employed as food scientists or within food marketing, research or product development areas, as this may have resulted in them having strongly formed views and greater knowledge on new product development than the average consumer. Furthermore, individuals were only recruited if they were consumers of the carrier products as the non-consumption of burger and sausages is likely to influence their attitudes towards the product concepts studied. Also, a period of three consecutive years of living in Ireland was required, in order to ensure participants' integration with Irish food consumption practices and food products to some extent. Finally, individuals were excluded if they spoke Chinese even at basic level, since this could interfere with one of the study measurements (the next section labelled "Intuitive evaluation- AMP task" justifies this decision). A total of 1,027 completed surveys were received.

5.6.3 Measures

Intuitive evaluation- AMP task

A variety of techniques for the measurement of unconscious evaluations[10] has been introduced in social psychological research. The Implicit Association Test (IAT), developed by Greenwald et al. (1998) and various forms of priming are probably the most well-known techniques (Fazio and Olson, 2003). In this study, intuitive evaluations towards the product concepts containing protein extracted from beef offal were measured with the Affect Misattribution Procedure (AMP) developed by Payne et al. (2005). The AMP procedure is a more recently developed technique which has been used in food studies (e.g. Woodward et al., 2017, Hofmann et al., 2009, Richard et al., 2017) exhibiting relatively high levels of reliability (Lebel and Paunonen, 2011). Payne and Lundberg (2014) reported Cronbach's alpha coefficients ranging from 0.47 to 0.95 from 45 studies. This method served the methodological scope of the current study, i.e. to measure intuitive evaluation towards the food products containing protein extracted from beef offal, while at the same time covered practical issues relating to the consumer survey, such as budget limitations and survey length time.

The AMP was named after the assumed cause of the priming effect: the unconscious affective reactions activated by the negative/positive prime is misattributed to the neutral object (Ecker and Bar-Anan, 2019). According to Payne et al. (2005), the AMP is an implicit measure, in the sense that participants do not report directly their attitudes, but the attitudes are inferred from the responses.

This priming-based procedure measures automatically activated responses based on the principle that exposure to a visual positive or negative stimulus causes an affective state, which then automatically biases the evaluation of a subsequent neutral object (Payne and Lundberg, 2014). According to AMP's principles, participants have to view pairs of pictures "*flashed*" rapidly one after the other; first

[10] In chapter 4, it was reported that different theorists and researchers have expressed different preferences for different terms when examining intuitive attitudes, such as "implicit", "unconscious" and "automatic".

the visual prime and then a neutral Chinese character[11] (Payne et al., 2005, p. 280). Then, they are asked to make evaluative judgments about the neutral target stimuli (i.e. Chinese character) while they are explicitly asked to ignore the photo prime. The stimulus (i.e. Chinese character) tends to be judged more positively (vs. negatively) when is preceded by positive (vs. negative) prime (Payne et al., 2005).

During the survey, each participant was exposed to a total of two AMP tasks, containing images from one of the six conditions. Every AMP task began with briefly showing (1200 ms)[12] a photograph of the product (burger/sausages) containing protein extracted from beef offal (visual prime). After the prime, a Chinese character[13] (see Fig. 5.4) was shown for 1200 ms. Participants were asked to rate the Chinese character in a scale, anchored from "not very pleasant" to "very pleasant", plus the option to report "unable to see the image" (Fig. 5.5). Before starting this part of the study, participants were explicitly instructed to ignore the photos prior to the Chinese characters. However, in accordance with AMP principles, it is expected that despite the given instruction, participants are more inclined to perceive the Chinese characters as pleasant if they have formed a favourable intuitive evaluation towards the visual primes, i.e. the food product containing protein extracted from beef liver/lung.

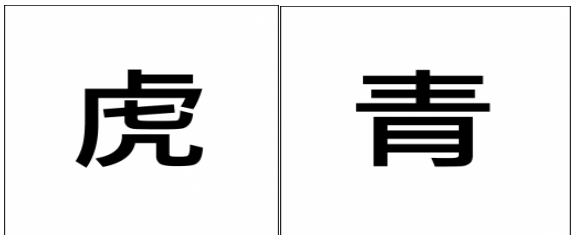


Figure 5.4 *Chinese characters used in the AMP*

[11] The research team decided that it was appropriate to exclude individuals who speak Chinese, since their knowledge of the meanings of the Chinese characters could alter the results from the AMP tests.
[12] Payne & Lundberg (2014) recommend using preferably less than 300 ms for both primes and Chinese characters to ensure subliminal presentation. However, they also suggested using the fastest time that is practical in a given study. Richard et al. (2017), for example extended the time period in their experiments (1500 ms). This study used 1200 ms presentation time after two pilot tests with 600 ms and 900 ms.
[13] Chinese characters were retrieved from Payne et al., (2005).

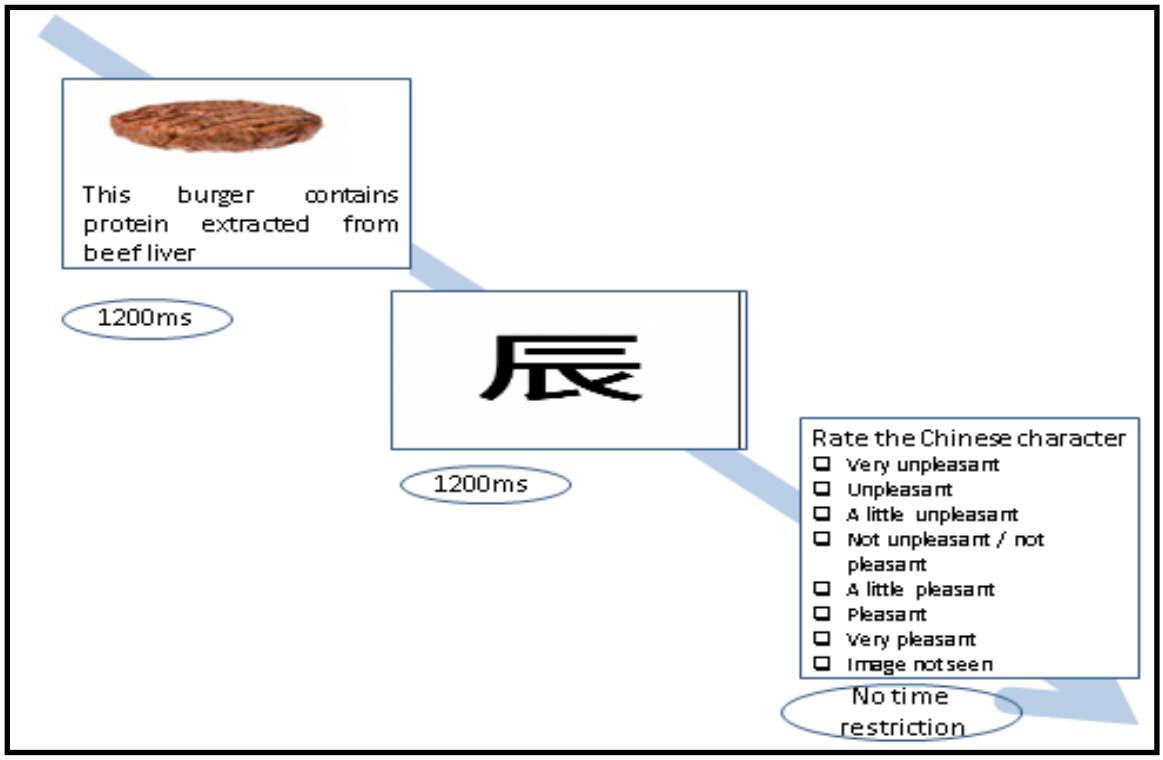


Figure 5.5 *Example of steps for the AMP task*

Overall attitude, Attitude ambivalence, Affective and cognitive attitude components, Deliberate evaluation and Acceptance measures

The attitudinal measures used in the survey follow. The order of these items was mixed in the online survey in order to avoid any intentional answering patterns in investigating constructs. For the same reason, the valence of the scale anchors was also mixed. Items denoted with (R) were reversed, so that higher scale scores denote positive valence.

Overall attitude

Different versions of scales consisting of various bi-polar adjectives have been used by researchers in order to measure overall attitudes to objects/products. "Good/bad" is by far the most commonly used bi-polar adjective and many of the scales have used also "favourable/unfavourable" (Bruner, 2014). In this study, participants' "*Overall attitude*" towards the food products containing protein extracted from beef offal was measured using three items on a seven-point bipolar continuum, in

accordance with Pham and Avnet (2004) and Kempf and Laczniak (2001) (reported Cronbach's alpha .97 and 9.4 respectively).

Specifically, participants were asked to indicate their attitudes in the following format:

"*Please indicate the position that best describes your overall opinion about this/these burger/sausages with added protein extracted from beef liver/lung*"

favourable	1	2	3	4	5	6	7	*unfavourable* (R)
likeable	1	2	3	4	5	6	7	*dislikeable* (R)
good	1	2	3	4	5	6	7	*bad* (R)

Attitude ambivalence

Participants' "attitude ambivalence" towards the product concepts was measured using three items on a seven-point scale in accordance with Priester and Petty (1996). This scale has been used in numerous research papers (e.g. Nowlis et al., 2002, Clark et al., 2008, Nordgren et al., 2006). The scale is composed of three items assessing the extent to which a person reports having mixed feelings when making an evaluation. The scale was used in the survey in the following format:

"This burger/these sausages with added protein extracted from beef liver/lung make(s) me feel…..

totally conflicted	1	2	3	4	5	6	7	*not conflicted at all*
totally indecisive	1	2	3	4	5	6	7	*not at all indecisive*
a completely mixed reaction	1	2	3	4	5	6	7	*a completely one sided reaction*

Affective and cognitive attitude component

The measurement of participants "*affective attitude component*" and "*cognitive attitude component*" towards the product concepts protein extracted from beef offal was based on the semantic differential scale developed by L. Jr. Crites et al. (1994). This scale was designed to be a relatively general measure of affect and cognition and can be applied across a wide range of attitude objects (Fabrigar and Petty, 1999). Items that were not directly relevant to the study (e.g. love/hateful) were removed as has been largely done in other research works when measuring affect and cognition in the food context (e.g. de Liver et al., 2005, Van Giesen et al., 2015, Koklic et al.,

2019). Five affective and five cognitive word pairs were used and participants were asked to indicate their position in the following format:

"This burger/these sausages with added protein extracted from beef liver/lung make(s) me feel…..

happy	1	2	3	4	5	6	7	*sad* (R)
bored	1	2	3	4	5	6	7	*excited*
pleasant	1	2	3	4	5	6	7	*unpleasant* (R)
concerned	1	2	3	4	5	6	7	*unconcerned*
disgusted	1	2	3	4	5	6	7	*delighted*

"I believe eating this burger/these sausages with added protein extracted from beef liver/lung would be…"

healthy	1	2	3	4	5	6	7	*unhealthy* (R)
unsafe	1	2	3	4	5	6	7	*safe*
unnatural	1	2	3	4	5	6	7	*natural*

"I believe producing this burger/these sausages with added protein extracted from beef liver/lung would be…"

beneficial	1	2	3	4	5	6	7	*harmful* (R)
unnecessary	1	2	3	4	5	6	7	*necessary*

Deliberate evaluation

Participants' "deliberate evaluation" towards the product concepts containing protein extracted from beef offal was assessed using three deliberate attitude items on a seven-point semantic differential scale from Bruner (2014) (Cronbach's $\alpha = .80$). This scale covers emotional, general and cognitive deliberate evaluations (de Beukelaar et al., 2019). Specifically, participants were asked to indicate their position in the following format:

"I believe eating this burger/these sausages with added protein extracted from beef liver/lung would be…"

not tasty	1	2	3	4	5	6	7	*tasty*

"I believe producing this burger/these sausages with added protein extracted from beef liver/lung would be…"

positive	1	2	3	4	5	6	7	*negative* (R)
meaningless	1	2	3	4	5	6	7	*meaningful*

Acceptability

Besides the attitudinal measurements towards the food products containing protein extracted from beef offal, it was deemed useful to measure individuals' acceptability towards these products. No specific hypotheses were made around acceptability, however, an explanatory analysis of the relationships between attitudinal constructs and acceptability will provide some additional insight. Acceptability was measured using three items on seven-point scale based on Tan et al. (2016) in the following format:

"*How acceptable do you think is this burger/these sausages with added protein extracted from beef liver/lung?"*

extremely acceptable	1	2	3	4	5	6	7	extremely unacceptable

"*Imagine that you are doing your grocery shopping and the price of this burger/these sausages with added protein extracted from beef liver/lung is the same as the one you usually buy. How willing are you to buy this burger/sausages with added protein extracted from beef liver/lung*?"

extremely willing	1	2	3	4	5	6	7	extremely unwilling

"*Imagine that there is a free tasting session, how willing would you be to taste this burger/these sausages with added protein are extracted from beef liver/lung*?

extremely willing	1	2	3	4	5	6	7	extremely unwilling

Participant characteristics

The following individual traits were also measured: (1) Attitudes towards healthiness of foods (2) Attitudes towards food and environment (3) Food neophobia and (4) Price consciousness and Convenience as food motives. All items were measured on a seven-point agreement scale with end points "strongly disagree" to "strongly agree". Also for these scales items were mixed and those items denoted with (R) were reversed.

- "*Attitudes towards healthiness of foods*"

Food healthiness is a key attribute influencing consumers' attitudes and food choice (Kraus, 2015). Krystallis et al. (2012) argue that when it comes to new processed meat products resulting from innovation with a possible health image, general health interest may be one of the most important psychological traits to shape purchase intention. Participants' orientation towards the healthiness of food was measured

using the general health interest scale developed by Roininen et al. (1999). The scale items were:

"The healthiness of food has little impact on my food choices" (R)
"I am very particular about the healthiness of the food I eat"
"I eat what I like and I do not worry much about the healthiness of food" (R)
"I always follow a healthy and balanced diet"
"It is important for me that my diet is low in fat"
"The healthiness of snacks makes no difference to me" (R)
"I do not avoid foods, even if they may raise the risk of certain health problems" (R).

- "*Attitudes towards food and environment"*

Concerns for the environmental effects of food production have been reported to influence consumers' attitudes and behaviours. For example, environmental concerns have been responsible for decreasing red meat consumption in the EU (McCarthy et al., 2003) and one of the main reasons for purchasing organic foods (Magnusson et al., 2003). Participants' "*Attitudes towards food and environment"* were measured with three items from Lindeman and Väänänen (2000):

"It is important that the food I eat on a typical day has been prepared in an environmentally friendly way"
"It is important that the food I eat on a typical day has been produced in a way which has not shaken the balance of nature"
"It is important that the food I eat on a typical day is packaged in an environmentally friendly way"

- Food neophobia

Food neophobia is a personality trait that has been related to acceptance of new foods (e.g. Siegrist, 2008, Tuorila et al., 1994, Verbeke, 2015), but also to evaluations of unfamiliar or new foods (e.g. Arvola et al., 1999). The food neophobia trait was assessed with the validated Food Neophobia Scale (FNS) developed by Pliner and Hobden (1992). Through this measure individuals can be located on a

continuum in terms of their tendency to approach or avoid unfamiliar food. The scale consists of the following items:

"I am constantly sampling new and different foods" (R)
"I don't trust new foods"
"If I don't know what a food is, I won't try it"
"I like foods from different cultures" (R)
"Ethnic food looks too weird to eat"
"At dinner parties, I will try new foods" (R)
"I am afraid to eat things I have never had before"
"I am very particular about the foods I eat"
"I will eat almost anything" (R)
"I like to try new ethnic restaurants" (R)

- Price consciousness and convenience as food choice motive

Price consciousness and convenience as motives underlying individuals' selection of food were measured. These measures were used to add insight into participants' profile in relation to their food choice motives. The subscales from Food Choice Questionnaire (FCQ) by Steptoe et al. (1995) were used to measure these constructs. The validity of these scales has been extensively tested, indicating that they are stable across cultures and over time (Scholderer et al., 2004). The scale items were:

"It is important to me that the food I eat on a typical day is good value for money"
"It is important to me that the food I eat on a typical day is not expensive"
"It is important to me that the food I eat on a typical day is cheap"
"It is important to me that the food I eat on a typical day is easy to prepare"
"It is important to me that the food I eat on a typical day can be bought in shops close to where I work or live"
"It is important to me that the food I eat on a typical day can be cooked very simply"

Participant demographics and control question

Participants were asked to provide demographic information about their age, gender, highest degree of education, social class and province of domicile. Moreover, to be able to control for participants' general attitudes towards the carrier products used in this study (burgers and sausages), participants were asked to evaluate these products on a 7-point Likert scale ranging from "not very positive" to "very positive" at the end of the survey in accordance with de Beukelaar et al. (2019). Finally, control questions regarding participants' attitudes towards the two Chinese characters were also performed at the end of the survey.

5.7 Pilot study

A pilot study, according to Saunders et al. (2007) is a "*Small-scale study to test a questionnaire, interview checklist or observation schedule, to minimise the likelihood of respondents having problems in answering the questions and of data recording problems as well as to allow some assessment of the questions' validity and the reliability of the data that will be collected*" (p. 597). As the questionnaire was designed for self-administration, a pilot study was particular important. Bryman and Bell (2007) suggest that "*pilot studies may be particular crucial in relation to research based upon the self-completion questionnaire, since there will not be an interviewer present to clear up any confusion*" (p. 170). In this study, pilot studies were applied in order to identify any questions that was unclear, any potential difficulties experienced due to the flow of the questionnaire and to determine how much time is needed for questionnaire completion.

The questionnaire was piloted in two stages. Initially, an internal piloting with six staff members and students from Teagasc was conducted. Using a convenience sample for piloting is a common strategy "*by virtue of its accessibility*" (Bryman and Bell, 2007, p.104). Feedback on formatting and comprehension of questions was incorporated into the final output. Following this, a second pilot stage was undertaken by the research using 50 participants. Questions regarding the comprehension and clarity of the survey were included and speed on answering set of questions and survey duration were checked. The data from the 50 completed

questionnaires were assessed indicating that there were no problems and the main survey proceeded.

5.8 Survey Procedure

A survey link was distributed by e-mail in December 2018 by the market research agency to its sample sources. After clicking the link, participants saw the "Information and consent form" (see Appendix IV). This form addressed the ethical principles adhered to the undertaking of this research. It should be noted that this research follows an Ethics and Data protection by design approach. This approach encompasses everything that deals with ethical standards of responsible research. Ethically informed participants provide ethically informed participation in terms of the scope and terms of survey, while privacy and protection are preserved throughout this research. Specifically, information regarding the purpose of the study and the protection and anonymity of the information provided were detailed in the "Information and consent form". Participants were informed that their participation is completely voluntary and that they are free to cease participation at any time. Participants were required to indicate that they had read this information and to provide consent/agreement to proceed with the survey.

The on-line survey (see Appendix IV) consisted of 5 parts which altogether took around 15 minutes to complete: (1) demographics, (2) AMP task, (3) ratings on Overall attitude, Attitude ambivalence, Affective and cognitive attitude components, Deliberate evaluation and Acceptance measures, (4) individual characteristics, and (5) control questions on overall attitudes towards the Chinese characters and towards burgers and sausages.

In part 1, demographic questions regarding age, gender, education, social class and geographical area were asked. Also, questions regarding the exclusion criteria were performed at this part (for study exclusion criteria see section 5.6.2 under "Recruitment of participants"). Once participants met the requirements to participate in the survey, they were randomly assigned to one of the 6 study conditions (for study conditions see section 5.6.2 under "Experimental design").

In part 2, participants completed the AMP task. A detailed description of the AMP task was provided in the previous section under the "Intuitive evaluation- AMP task" title[14].

In part 3, participants rated *overall attitude*, *attitude ambivalence*, *affective* and *cognitive attitude components*, *deliberate evaluation* and *acceptance* of the food product containing protein extracted from beef offal.

In part 4, participants filled in the *Food neophobia scale*, rated their *attitudes towards healthiness of foods* and their *attitudes towards food and environment* and reported the importance of *Convenience and Price as food choice motives*.

In the last part, part 5, participants rated their general attitudes towards eating burgers and sausages and their attitudes towards the Chinese characters. Finally, participants were thanked for their participation.

5.9 Data Analysis

Data analysis of the consumer survey was performed using IBM SPSS 24, a Statistical Package for the Social Sciences which is "*..a powerful data analysis and statistics program specially tailored to the requirements of social science researchers*" (Buckingham and Saunders, 2009 p. 155). The variables used for the measurement of quantitative data can be categorical or continuous and can have different levels of measurements (Field, 2009). In this study both types were used: binary variables where there were only two categories measured (e.g. male or female); ordinal variables where there were more than two categories measured but the categories had logical order (e.g. whether someone has primary, secondary or third level education level); and interval variables were equal intervals on the variable represented equal differences in the property being measured (e.g. the difference between 1 and 2 is equivalent to the difference between 5 and 6 in a scale measuring attitude from "bad" to "good").

[14] Part 2 and part 3 were presented twice to each participant. One time concerned the burger product concept containing protein extracted from beef offal and the other the sausages product concept containing protein extracted from beef offal.

Data analyses consisted of:

- Statistical validity of scales: reliability analysis (Cronbach's alpha), test of unidimensionality (factor analysis)
- Descriptive statistics: frequencies, cross tabulation, Pearson's chi-square correlations
- Comparison of means: regression analysis, Analysis of variance (ANOVA),

Statistical validity of scales

In order to analyse the results from the consumer survey, it was necessary to assure statistically validity of the scales used. This process involved two separate tests; the test of unidimensionality and the test of reliability. In order to use a summed scale it is essential to prove that the items which form the scale are unidimensional, and represent a single concept. Factor analysis was used to test the dimensionality of the scales. Each scale should consist of items loading on a single factor. Reliability analysis determines how well a set of questions (i.e. item) go together into a single scale. It therefore assesses the internal consistency of a scale. This analysis also reveals how strongly each item in the scale is associated with the overall scale. In order to assess reliability of scales used, Cronbach's alpha was calculated. Value exceeding .70 is an acceptable value for Cronbach's alpha, although .60 can be expected when dealing with psychological constructs (Field, 2009).

Descriptive statistics

Descriptive statistics are the most basic form of statistical analysis and they provide an "*instant picture*" of the data distribution (Field, 2009, p. 141). Janssens et al. (2008) state that descriptive statistics "are *used to obtain a descriptive overview of the data at hand, and summarize the data by means of a limited number of statistical indicators*" (p.1). Frequency tables were used in order to acquire a descriptive idea of any patterns within the data (e.g. frequencies of consumption) while Pearson's chi-square test with cross-tabulation tables were used in order to look at the relationships between any categorical variables (e.g. is burger consumption frequency age-related?). Field (2009) explains that Pearson's chi-square test "...*is an extremely elegant statistic based on the simple idea of comparing the frequencies you observe*

in certain categories to the frequencies you might expect to get in those categories by chance" (p. 688).

Pearson's chi-square test is given by the equation:

$$\chi^2 = \sum \frac{(observed_{ij} - model_{ij})^2}{model_{ij}}$$

in which i represents the rows in the contingency table and j represents the columns

Pearson's correlation coefficient, r, is used to investigate whether two variables are related, and whether changes in one variable are met with similar changes in the other variable (Field, 2009). The correlation coefficient lies between -1 and +1, with a coefficient of +1 indicating a perfect positive relationship between the variables, a coefficient of -1 indicating a perfect negative relationship and a coefficient of 0 indicating no linear relationship at all. A correlation coefficient does not indicate any causality, however, when squared (i.e. coefficient of determination, R^2) it is a measure of the amount of variability in one variable that is shared by the other (Field, 2009).

Correlation coefficient is defined by the equation:

$$r = \frac{\sum(x_i - \bar{x})(y_i - \bar{y})}{(N-1)s_x s_y}$$

in which $\bar{x}$ and $\bar{y}$ are the means of the variables, s_x is the standard deviation of the first variable, s_y is the standard deviation of the second variable, *N* is the number of observations.

Comparisons of means

Regression analysis is a way of predicting an outcome variable from one predictor variable (simple regression) or several predictor variables (multiple regression). This is done by fitting a statistical model to the data in the form of a straight line (Field,

2009). Assessing how well the line fits the data is done by using the R^2 which shows how much variance is explained by the model (i.e. the proportion of the variance in the outcome variable that is shared by the predictor variable), and by the *F*-ratio which shows how much variability the model can explain relative to how much it cannot explain (Field, 2009). The *b*-values show the strength of the relationship between a predictor and the outcome variable.

The simple regression model equation is:

$$Y_i = (b_0 + b_1 X_i) + \varepsilon_i$$

where Y_i is the outcome that we want to predict, X_i is the $_i$th participant's score on the predictor variable, and b_0 and b_i the regression coefficients. Multiple regression is an extension of simple regression in situations where there are several predictors.

Analysis of variance (ANOVA) is a method of comparing the means of two or more groups (Field, 2009). ANOVA is a special case of regression, which "*due to two distinct branches of methodology research developed in the social sciences i.e. correlational research and experimental research*" was mostly chosen in controlled experiments, whereas regression was mostly chosen for real-world relationships investigations (Field, 2009, p. 349).

The ANOVA test produces an F-ratio, with a large F-ratio being translated as higher variability caused by the independent variable (explained variance) than by chance (error variance). When ANOVA is conducted on more than two groups, further analysis is needed in order to uncover which of the groups differ. *Post-hoc* analysis techniques are used for this purpose. If specific hypotheses on groups differences have been generated before the analysis, *planned contrasts* (or *planned comparisons*) should be used to test these hypotheses (Field, 2009). However, it is often the case that no specific *a priori* hypotheses regarding the group mean differences has been made, and instead an exploration for any between-group mean differences is conducted. In this case, *post hoc* tests consist of "*pairwise comparisons that are*

designed to compare all different combinations" (Field, 2009, p. 372). Field (2009) explains that there is always a trade-off to consider when choosing a *post-hoc* test, as when a test is conservative (probability of Type I error is small) then it usually lacks statistical power (probability of Type II is high). When sample sizes are equal and the population variances are similar, *Tukey's* test has a tight control over Type I error and good statistical power (Field, 2009). *Bonferroni's* test is generally conservative and should be used when strict control over Type I error is needed (Field, 2009). Other *post hoc* tests apply when sample sizes are unequal or there are doubts regarding the population variances (e.g. *Games-Howell* procedure, the Ryan, Einot, Gabriel and Welsch Q procedure (*REGWQ*), *Dunnett's T3*).

5.10 Conclusion

This chapter has presented the research considerations and activities undertaken in order to address the objectives of this study. The research paradigm and methodological approach underlying this work enabled the examination of the research questions posed early in this study. Specifically, the positivist research paradigm and the quantitative approach, which have been described and justified, proved effective in revealing consumers' attitudes towards food products containing protein extracted from beef offal and the attitude processes which dominate attitude formation towards these products. A consumer survey enabled a rich dataset to be collected which allowed the author to test and establish robust cause effect relationships for the phenomena observed. The chapter ends with a review of the data analysis techniques used to assess the results. The next chapter will present the results obtained from the consumer survey.

6 Results

6.1 Introduction

The aim of this research is to explore Irish consumers' attitudes to incorporating protein extracted from beef offal into food products. In this chapter the results from the on-line survey that addressed this aim are presented. It begins by profiling the sample and providing descriptive statistics regarding burger and sausage consumption. These consumption statistics are further discussed across different socio-demographic factors in order to acquire a nuanced understanding of differences across different demographic groups. Next, in order to facilitate the consideration of the hypotheses, a description of all variables used in the analysis is presented. Following this, an overview of the main measured variables (i.e. intuitive evaluation, deliberate evaluation, overall attitude and acceptance) across the study conditions and products are provided. This overview provides a general picture of trends regarding participants' evaluations and attitudes towards the food products under research. Prior to testing the hypotheses, an examination of correlations among socio-demographics variables and the main measured variables, as well as an examination of relationships among the main variables is undertaken in order to acquire an insight of the relationships between these variables.

Assessing the relevance of the proposed research model by examining the specific hypotheses is the core part of this analysis. In effect, the analysis presented examines if attitudes towards food products containing protein extracted from beef offal are influenced by affective and/or cognitive factors and to what extent these attitudes can be predicted by intuitive and deliberate evaluations. Moreover, this analysis considers whether information provision and product familiarity influence attitude formation processes and the attitudes towards food products containing protein extracted from beef offal.

6.2 Data analysis

The data obtained from this survey were analysed using IBM SPSS Statistics version 24, with a critical p-value of .05. Summary descriptive statistics of ordinal data are presented as frequencies (e.g. results of frequencies of consumption). Continuous variables are presented as means and standard deviations. The process of data analysis in this thesis should be thought of as taking place in two phases: (a)

exploration and description of the data (section 6.2) and (b) hypotheses testing (section 6.3).

6.2.1 Participant demographics and characteristics

A total of 1,027 consumers took part in the survey. People who reported not seeing the image(s) for the "intuitive evaluation" section were excluded from the analysis. This was necessary, as completion of this section in accordance with the AMP method is essential for the hypotheses testing. Seventy-four participants were excluded based on this criterion. Possible causes for failure to complete the section could be limitations associated with the devices on which the survey was undertaken (e.g. phone with a small screen) in combination with the short duration for which the images were presented. Thus, 953 people were included in the final analysis.

Table 6.1 shows an overview of the participants' demographics. The study sample is representative of the Irish adult population in terms of gender, age, education and social class (according to the most recent Census survey, conducted by the Central Statistics Office (CSO)[15] in 2016). Moreover, Pearson's chi squares show that participants were equally assigned across the six experimental conditions, with respect to the above mentioned characteristics.

Table 6.1 *Participant demographics (n=953) and Pearson's χ^2 to insure no sampling bias across the 6 study conditions*

	CSO %	n=953	percentage	Distribution across survey conditions
Gender				$\chi^2(5)=3.99$, $p=.55$
Male	48.9	492	51.6%	
Female	51.1	461	48.4%	
Age category				$\chi^2(25)=18.86$, $p=.84$
18-24	11.2	85	8.9%	
25-34	18.5	166	17.4%	
35-44	20.6	214	22.5%	
45-54	17.6	191	20.0%	
55-64	14.2	159	16.7%	
65+	17.9	138	14.5%	

[15] CSO data correspond to population aged 15 years and over.

Highest level of education completed (n=953)				$\chi^2(15)=17.96$, $p=.26$
Primary school	11.7	7	0.7%	
Secondary school	45.5	272	28.5%	
Third level (non-degree i.e. Diploma, Certificate)	11.7	327	34.3%	
Third level (degree or higher i.e. Undergraduate, Postgraduate, PhD, etc.)	30.9	347	36.4%	
Social Class				$\chi^2(20)=21.98$, $p=.34$
AB	24.3	203	21.3%	
C1	17.1	304	31.9%	
C2	37.3	142	14.9%	
DE	14.8	292	30.6%	
F	6.6	12	1.3%	
Province of residence				$\chi^2(20)=23.49$, $p=.27$
Dublin	22.8	280	29.4%	
Rest of Leinster	21.4	252	26.4%	
Munster	33.7	274	28.8%	
Connacht	14.5	100	10.5%	
Ulster (part of ROI)	7.6	47	4.9%	
Survey condition				
Familiar + no information		161	16.9%	
Familiar + benefit information		155	16.3%	
Familiar + ambiguous information		164	17.2%	
Unfamiliar + no information		158	16.6%	
Unfamiliar + benefit information		159	16.7%	
Unfamiliar + ambiguous information		156	16.4%	

Participants' general attitudes towards the two product carriers indicate that participants were equally positive about consuming burgers (M= 4.65, SD= 1.49) and sausages (M=4.85, SD= 1.43). Moreover, participants' general attitudes towards the two Chinese signs, which were used as the stimuli items in the "intuitive evaluation" section of the survey, in accordance with the AMP method, showed similar results (Sign 1: M=3.65, SD=1.12; Sign 2: M=3.70, SD=1.07). A within subjects repeated measures ANOVA, showed no significant differences between participants' attitudes towards the two Chinese signs [($F(1,952) = 3.83$, p =.05, partial $\eta^2 = 0.004$], which

suggests that the two Chinese signs were perceived as equal by participants with regard to attractiveness. This was important to test in order to ensure that any possible statistical difference in participants' intuitive evaluations did not occur due differences in perceived attractiveness towards the Chinese signs.

Participants' levels of food neophobia, attitudes to food and the environment, attitudes towards healthiness of foods, and importance of convenience and price as food choice motives were measured by corresponding statements for each construct (see Table 6.2) (the statements used to measure each construct can be found in Section 4.9). Each construct was measured using a seven point Likert scale ranging from "strongly disagree" (1) to "strongly agree" (7) with 1 expressing negative valence and 7 expressing positive valence. Descriptive results and reliability analysis of these scales are shown in Table 2. Constructs' reliability was measured using Cronbach's alpha, with all results indicating sufficient reliability. The general cut-off point for Cronbach's alpha is 0.7, although 0.60 can be expected when dealing with psychological constructs (Field, 2005).

Table 6.2 *Descriptive results and reliability test of Food neophobia, Convenience as food choice motives, Price as food choice motive, Attitudes towards healthiness of foods and Attitudes to food and environment scales (measured on a 7-point scale) (n=953)*

Scale	Mean	Std. Deviation	Cronbach's α
Food neophobia	3.18	1.19	.87
Convenience as food choice motive	5.15	0.95	.69
Price as food choice motive	4.93	1.02	.72
Attitudes towards healthiness of foods	4.55	0.96	.61
Attitudes to food and environment	4.84	1.24	.88

6.2.2 Burger and sausage consumption

Participants were asked how frequently they consume burgers and sausage. As illustrated in Table 6.3, more than two-thirds of the participants (almost 73%) reported eating burgers "less than once per month" or "1-3 times per month", whereas almost two third of the sample (64%) reported eating sausages "once a week" or "1-3 times per month". These reported frequencies indicate that sausages

are consumed by more people, more frequently than burgers. It should be noted that this sample represents burger and sausage consumers, since non-consumers were excluded from the survey.

Table 6.3*Frequency of burger and sausage consumption (%) (n=953)*

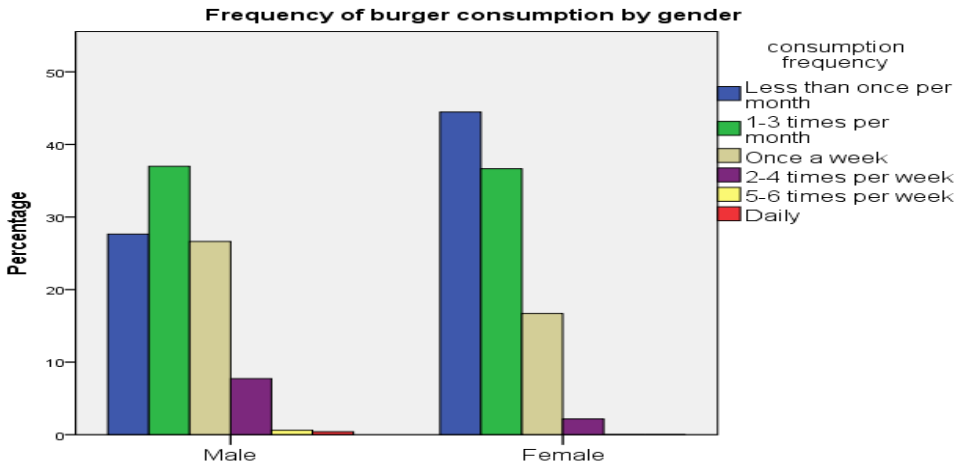
	Less than once per month	1-3 times a month	Once a week	2-4 times per week	5-6 times per week	Daily
Burger	35.8%	**36.8%**	21.8%	5%	0.3%	**0.2%**
Sausage	19.6%	29.2%	**35%**	13%	2.3%	**0.8%**

Highest value Lowest value

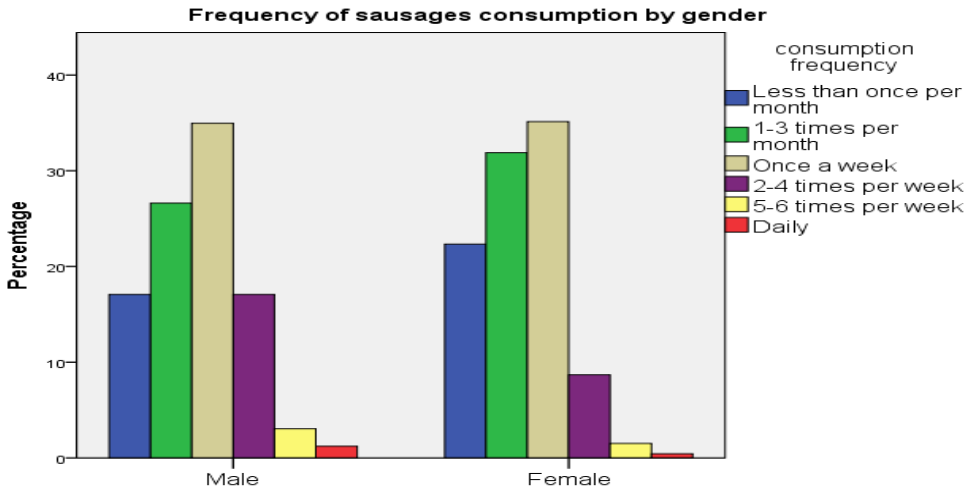
Burger and sausage consumption across different socio-demographic factors

Frequency of burger and sausage consumption was examined by gender, age, education level and social class. These socio-demographics variables have been cited in previous food studies as being associated with food choice patterns. Analysis was conducted with Pearson's chi-square and the results were verified after analysing with Fisher exact test and sensitivity checking by collapsing some categories. This further test was conducted as small expected frequencies were observed (less than 5) in the cross tabulation tables.

There was a significant difference in burger and sausage consumption level based on gender ($\chi^2(5) = 48.84$, $p = .00$, and $\chi^2(5) = 22.69$, $p = .00$, respectively). In the case of burgers, men reported eating burgers more frequently than women. The largest group of females (44.5%) reported eating burgers "less than once per month" followed by "1-3 times per month" (36.7%). In comparison, the largest group of men (37%), reported eating burgers "1-3 times per month" followed by "less than once per month" (27.6%) and "once a week" (26.5%) (Fig. 6.1a). While there is a statistically significant difference in sausage consumption according to gender, the largest percentage for both men and women reported eating sausages "once a week" (35%). However, more men (17.1 %) reported having sausages "2-4 times per week" in comparison to women (8.7%) and more women reported having sausages "1-3 times per month" (32%) and "less than once per month" (22.3%) in comparison to men (26.6% and 17.1% respectively) (Fig. 6.1 b).



(a)



(b)

Figure 6.1 *Frequency of burger (a) and sausage (b) consumption by Gender*

Significant differences were observed in consumption levels of burgers in respect of age ($\chi^2(25) = 90.82$, $p = .00$). Older participants tend to consume burgers less frequently than younger participants. As evident in Table 6.4, participants aged below 44 years old, reported eating burgers "1-3 times per month", however, participants belonging to the older age groups, "45-54", "56-64" and "65+", reported eating burgers "less than once per month". No significant differences in sausage consumption were observed in respect of age ($\chi^2(25) = 32.98$, $p = .32$). "Once a week" was reported as the most common frequency of sausage consumption across almost all age groups, followed by "1-3 times per month". The only exception is the age group "25-34" where most participants reported having sausages more rarely in comparison to other age groups (see Table 6.5).

Table 6.4 *Burger consumption by Age groups with chi-square test*

	18-24 (n=85)	25-34 (n=166)	35-44 (n=214)	45-54 (n=191)	55-64 (n=159)	65+ n=138)	Total
Less than once per month							
% within age group	20	27.1	22.4	38.7	49.1	57.2	35.8
% within burger consumption	5	13.2	14.1	21.7	22.9	23.2	100
1-3 times per month							
% within age group	40.0	36.8	45.3	33.5	32.7	29.0	36.8
% within burger consumption	9.7	18.2	27.6	18.2	14.8	11.4	100
Once a week							
% within age group	34.1	24.1	27.1	23.0	13.8	10.9	21.8
% within burger consumption	13.9	19.2	27.9	21.2	10.6	7.2	100
2-4 times per week							
% within age group	5.9	8.4	4.7	4.2	4.4	2.9	5.0
% within burger consumption	10.4	29.2	20.8	16.7	14.6	8.3	100
5-6 times per week							
% within age group	0.0	1.2	0.5	0.0	0.0	0.0	0.3
% within burger consumption	0.0	66.7	33.3	0.0	0.0	0.0	100
Daily							
% within age group	0.0	0.6	0.0	0.5	0.0	0.0	0.2
% within burger consumption	0.0	50.0	0.0	50.0	0.0	0.0	100
Total							
% within burger consumption	8.9	17.4	22.5	20.0	16.7	14.5	100
					Burger	$\chi^2(25) = 90.82$, ***p* = .00**	

Largest percentage of burger consumption within age group

Table 6.5 *Sausage consumption by Age groups with chi-square test*

	18-24 (n=85)	25-34 (n=166)	35-44 (n=214)	45-54 (n=191)	55-64 (n=159)	65+ n=138)	Total
Less than once per month							
% within age group	18.8	14.5	12.1	23.0	26.4	25.4	19.6
% within sausage consumption	8.6	12.8	13.9	23.5	22.5	18.7	100
1-3 times per month							
% within age group	27.1	36.7	29.9	26.7	24.5	29.0	29.2
% within sausage consumption	8.3	21.9	23.0	18.3	14.0	14.4	100
Once a week							
% within age group	36.5	28.9	39.7	35.1	34.6	34.8	35
% within sausage consumption	9.3	14.4	25.4	20.1	16.5	14.4	100
2-4 times per week							
% within age group	12.9	15.7	14.5	12.6	12.6	8.7	13.0
% within sausage consumption	8.9	21.0	25.0	19.4	16.1	9.7	100
5-6 times per week							
% within age group	3.5	2.4	2.8	1.6	1.9	2.2	2.3
% within sausage consumption	13.6	18.2	27.3	13.6	13.6	13.6	100
Daily							
% within age group	1.2	1.8	0.9	1.0	0.0	0.0	0.8
% within sausage consumption	12.5	37.5	25.0	25.0	0.0	0.0	100
Total							
% within sausage consumption	8.9	17.4	22.5	10.0	16.7	14.5	100
					Sausages	$\chi^2(25) = 32.98$, $p = .32$	

Largest percentage of sausage consumption within age group

Education Level was not found to be associated with consumption levels of burger ($\chi^2(15) = 18.65$, $p = .23$). Specifically, "less than once per month", and "1-3 times per month", were the most common reported consumption frequencies of burger across all education levels (see Table 6.6). However, Education Level was found to be associated with consumption levels of sausage ($\chi^2(15) = 31.48$, $p = .00$). As shown in Table 6.7, participants with the highest education level consume sausages less frequently than responders with lower education level.

Table 6.6 *Burger consumption by Education level with chi-square test*

	Primary (n=7)	Secondary (n=272)	Third (non-degree) (n=327)	Third degree or higher (n=347)	Total
Less than once per month					
% within education group	71.4	33.8	37.6	34.9	35.8
% within burger consumption	1.5	27.0	36.1	35.6	100
1-3 times per month					
% within education group	0.0	33.8	33.9	42.7	36.8
% within burger consumption	0.0	26.2	31.6	42.2	100
Once a week					
% within education group	28.6	24.6	23.2	18.2	21.8
% within burger consumption	1.0	32.2	36.5	30.3	100
2-4 times per week					
% within education group	0.0	7.0	4.9	3.7	5.0
% within burger consumption	0.0	39.6	33.3	27.1	100
5-6 times per week					
% within education group	0.0	0.4	0.3	0.3	0.3
% within burger consumption	0.0	33.3	33.3	33.3	100
Daily					
% within education group	0.0	0.4	0.0	0.3	0.2
% within burger consumption	0.0	50.0	0.0	50.0	100
Total					
% within burger consumption	0.7	28.5	34.3	36.4	100.0
			Burger	$\chi^2(15) = 18.65$, $p = .23$	

Largest percentage of burger consumption within Education level category

Table 6.7 *Sausage consumption by Education level with chi-square test*

	Primary (n=7)	Secondary (n=272)	Third (non-degree) (n=327)	Third degree or higher (n=347)	Total
Less than once per month					
% within education group	0.0	15.8	19.6	23.1	19.6
% within sausage consumption	0.0	23.0	34.2	42.8	100
1-3 times per month					
% within education group	28.6	26.1	25.4	35.2	29.2
% within sausage consumption	0.7	25.5	29.9	43.9	100
Once a week					
% within education group	71.4	39.0	38.2	28.2	35.0
% within sausage consumption	1.5	31.7	37.4	29.3	100

2-4 times per week					
% within education group	0.0	16.9	12.8	10.4	13.0
% within sausage consumption	0.0	37.1	33.9	29.0	100
5-6 times per week					
% within education group	0.0	1.1	3.4	2.3	2.3
% within sausage consumption	0.0	13.6	50.0	36.4	100
Daily					
% within education group	0.0	1.1	0.6	0.9	0.8
% within sausage consumption	0.0	37.5	25.0	37.5	100
Total					
% within sausage consumption	0.7	28.5	34.3	36.4	100
			Sausage	$\chi^2(15) = 31.48$, ***p* = .00**	

Largest percentage of sausage consumption within Education level category

Social class was found to be associated with consumption frequencies of both burgers and sausages ($\chi^2(20) = 45.23$, $p < .05$ and $\chi^2(20) = 52.50$, $p < .05$, respectively). Participants from higher social classes reported eating burgers more frequently than those in lower social classes (see Table 6.8). This contrasts with the situation regarding sausage consumption, where responders of lower social class reported eating sausages more frequently than higher social class responders (see Table 6.9).

Table 6.8 *Burger consumption by Social Class with chi-square test*

	AB (n=203)	**C1 (n=304)**	**C2 (n=142)**	**DE (n=292)**	**F (n=12)**	**Total**
Less than once per month						
% within social class group	35.0	28.6	30.3	46.6	33.3	35.8
% within burger consumption	20.8	25.5	12.6	39.9	1.2	100
1-3 times per month						
% within social class group	37.4	42.4	36.6	30.8	33.3	36.8
% within burger consumption	21.7	36.8	14.8	25.6	1.1	100
Once a week						
% within social class group	22.7	22.0	25.4	19.9	8.3	21.8
% within burger consumption	22.1	32.2	17.3	27.9	0.5	100
2-4 times per week						
% within social class group	3.9	6.9	6.3	2.4	25.0	5.0
% within burger consumption	16.7	43.8	18.8	14.6	6.3	100
5-6 times per week						
% within social class group	0.5	0.0	0.7	0.3	0.0	0.3
% within burger consumption	33.3	0.0	33.3	33.3	0.0	100
Daily						
% within social class group	0.5	0.0	0.7	0.0	0.0	0.2
% within burger consumption	50.0	0.0	50.0	0.0	0.0	100
Total						
% within burger consumption	21.3	31.9	14.9	30.6	1.3	100
				Burger	$\chi^2(15) = 45.23$, ***p* = .00**	

Largest percentage of burgers consumption within Social class category

Table 6.9 *Sausage consumption by Social Class with chi-square test*

	AB (n=203)	C1 (n=304)	C2 (n=142)	DE (n=292)	F (n=12)	Total
Less than once per month						
% within social class group	24.6	14.8	14.1	24.7	0.0	19.6
% within sausage consumption	26.7	24.	10.	38.5	0.0	100
1-3 times per month						
% within social class group	30.0	34.2	19.7	28.1	25.0	29.2
% within sausage consumption	21.9	37.4	10.1	29.5	1.1	100
Once a week						
% within social class group	26.6	37.2	44.4	33.9	41.7	35.0
% within sausage consumption	16.2	33.8	18.9	29.6	1.5	100
2-4 times per week						
% within social class group	15.3	11.2	14.1	12.0	33.3	13.0
% within sausage consumption	25.0	27.4	16.1	28.2	3.2	100
5-6 times per week						
% within social class group	2.5	1.3	6.3	1.4	0.0	2.3
% within sausage consumption	22.7	18.2	40.9	18.	0.0	100
Daily						
% within social class group	1.0	1.3	1.4	0.0	0.0	0.8
% within sausage consumption	25.0	50.0	25.0	0.0	0.0	100
Total						
% within sausage consumption	21.3	31.9	14.9	30.6	1.3	100
			Sausage	$\chi 2(15) = 45.23$, ***p = .00***		

Largest percentage of sausages consumption within Social Class category

6.2.3 Description of variables

An overview of all variables used in the analysis with related dimensionality and reliability analyses of measures is presented in Table 6.10 (detailed discussion on the measurements used in the survey can be found in Section 4.9). All variables were found to be uni-dimensional and displayed good reliability as indicated by factor analysis of dimensionality and Cronbach's alpha respectively. Each variable was calculated as the mean of its corresponding items. In order to get the mean scores of the items, a consistent coding for all items is required. Negative to positive coding, with 1 expressing negative valence and 7 expressing positive valence was used for measuring every item. Therefore, reverse coding was performed on items that were presented in opposite valence in the survey, before computing the average score.

Table 6.10 *Overview of study items, factor analysis of dimensionality and reliability analysis.*

Variable									Factor Loading	Mean	Standard Deviation
Intuitive evaluation *											
very unpleasant	1	2	3	4	5	6	7	*very pleasant*	-	3.74	1.06
Deliberate evaluation											
not tasty	1	2	3	4	5	6	7	*tasty*	.88	4.16	1.65
positive	1	2	3	4	5	6	7	*negative* (R)	.92	3.85	1.58
meaningless	1	2	3	4	5	6	7	*meaningful*	.91	3.79	1.58
											% of variance: 81, Cronbach's α = .88
Overall attitude											
favourable	1	2	3	4	5	6	7	*unfavourable* (R)	.98	3.95	1.76
likeable	1	2	3	4	5	6	7	*dislikeable* (R)	.98	3.85	1.72
good	1	2	3	4	5	6	7	*bad* (R)	.98	3.96	1.69
											% of variance: 96, Cronbach's α = .98
Acceptance											
extremely acceptable	1	2	3	4	5	6	7	*extremely unacceptable* (R)	.81	3.92	1.67
extremely unwilling to buy	1	2	3	4	5	6	7	*extremely willing to buy*	.93	3.57	1.81
extremely unwilling to try	1	2	3	4	5	6	7	*extremely willing to try*	.89	4.23	1.95
											% of variance: 77, Cronbach's α = .85
Attitude affective component *											
happy	1	2	3	4	5	6	7	*sad* (R)	.91	3.82	1.55
bored	1	2	3	4	5	6	7	*excited*	.79	3.73	1.31
pleasant	1	2	3	4	5	6	7	*unpleasant* (R)	.92	3.66	1.56
concerned	1	2	3	4	5	6	7	*unconcerned*	.80	3.98	1.64
disgusted	1	2	3	4	5	6	7	*delighted*	.92	3.81	1.52
											% of variance: 76, Cronbach's α = .92
Attitude cognitive component											
healthy	1	2	3	4	5	6	7	*unhealthy* (R)	.92	4.13	1.65
unsafe	1	2	3	4	5	6	7	*safe*	.91	4.30	1.63
unnatural	1	2	3	4	5	6	7	*natural*	.90	3.79	1.71
beneficial	1	2	3	4	5	6	7	*harmful* (R)	.92	4.22	1.58
unnecessary	1	2	3	4	5	6	7	*necessary*	.87	3.47	1.63
											% of variance: 81, Cronbach's α = .94
Attitude ambivalence											
totally conflicted	1	2	3	4	5	6	7	*not conflicted at all*	.79	4.31	1.55
totally indecisive	1	2	3	4	5	6	7	*not at all indecisive*	.89	4.45	1.49
a completely mixed reaction	1	2	3	4	5	6	7	*a completely one sided reaction*	.84	4.27	1.48
											% of variance: 70, Cronbach's α = .79

*** These two measures will not be used in the same model**

(R) denotes that items were reversed prior to analysis

All variables listed in Table 6.10 were initially measured separately for both product concepts i.e. burger and sausage. As discussed in the previous chapter, and in accordance with de Beukelaar et al. (2019), the inclusion of two products served as internal replication and to control for individual differences in liking of specific products. For testing the hypotheses, the two scores for the constructs for the individual products (burger and sausages) were averaged to get a single aggregated score for each variable. Figure 6.2 depicts the process of computing the variable "overall attitude" as an example. Initially "overall attitude to burger containing protein extracted from beef offal" was calculated by the average of the three items that were used to measure this construct (favourable-unfavourable, likeable-dislikeable, bad-good). Afterwards, "overall attitude to sausage containing protein extracted from beef offal" was calculated in the same way. These two scores i.e. "overall attitude to burger containing protein extracted from beef offal" and "overall attitude to sausage containing protein extracted from beef offal " were averaged in order to get a single score for the variable "overall attitude". The same process was undertaken in order to compute every variable.

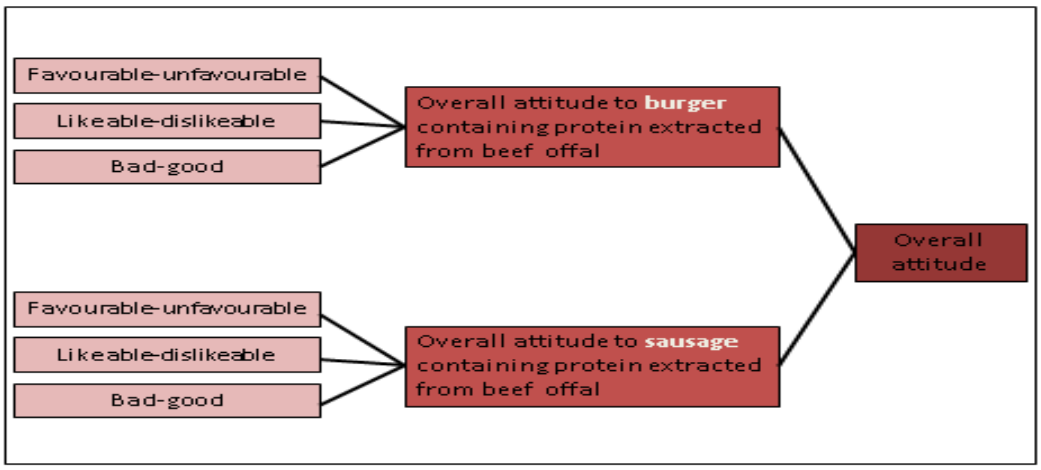


Figure 6.2 *Steps to compute "overall attitude" variable*

6.2.4 Main measured variables across conditions and products

An overview of the means and standard deviations for the main measured variables is provided in Table 6.11 and Table 6.12. For almost all variables the highest values are noted when benefit information is provided and when protein is extracted from

liver rather than from lung. In comparison, the lowest values are noted when no information is provided and when protein is extracted from lung. Moreover, when comparing the variable scores acquired for the two product carriers i.e. burgers versus sausages, it can be seen that they do not show differences for the scores. This confirms that it is reasonable to average the measures coming for the two products in order to get an aggregated score for each variable.

Table 6.11 *Means (SD) for intuitive evaluation, deliberate evaluation, overall attitude and acceptance for burger tabulated by study conditions (measured on a 7-point scale) (n=953)*

	protein extraction source	intuitive evaluation	deliberate evaluation	overall attitude	acceptance
No info	Liver	**3.57** (1.18)	3.74 (1.34)	3.92(1.70)	3.92(1.59)
	Lung	3.58 (1.31)	**3.33**(1.48)	**3.19** (1.74)	**3.14** (1.68)
Benefit info	Liver	**3.75** (1.36)	**4.39** (1.50)	**4.50** (1.78)	**4.37** (1.52)
	Lung	3.66 (1.10)	4.16 (1.62)	4.15 (1.67)	4.19 (1.62)
Ambiguous info	Liver	3.70 (1.14)	4.16 (1.30)	4.24 (1.62)	4.20 (1.47)
	Lung	3.63 (1.17)	4.03(1.56)	3.89(1.90)	3.80 (1.68)

Highest value Lowest value

Table 6.12 *Means (SD) for intuitive evaluation, deliberate evaluation, overall attitude and acceptance for sausages tabulated by study conditions (measured on a 7-point scale) (n=953)*

	protein extraction source	intuitive evaluation	deliberate evaluation	overall attitude	acceptance
No info	Liver	3.84 (1.28)	3.70 (1.48)	3.57 (1.82)	3.81 (1.65)
	Lung	**3.72** (1.31)	**3.40** (1.56)	**3.12** (1.87)	**3.20** (1.76)
Benefit info	Liver	3.82 (1.33)	**4.25** (1.54)	**4.30** (1.71)	**4.26** (1.53)
	Lung	3.77 (1.09)	4.15 (1.62)	4.25 (1.83)	4.17 (1.73)
Ambiguous info	Liver	**4.00** (1.04)	4.12 (1.38)	4.17 (1.63)	4.17 (1.53)
	Lung	3.81 (1.29)	3.75(1.58)	3.78 (1.87)	3.68 (1.74)

Highest value Lowest value

6.2.5 Effect of participants socio-demographic characteristics on measured variables

In order to examine if demographic groups differ in their reported evaluations, a first exploratory analysis between socio-demographic characteristics and participants' response measures was undertaken. Because there were no specific hypotheses, it is more meaningful to treat this analysis as exploratory only, not reaching firm conclusions of cause and effect. Therefore, the pairwise comparisons are made without p-value adjustment and Tukey post hoc analysis was chosen since it is a test that balances conservativeness with good statistical power.

One way ANOVAs revealed that none of the socio-demographic variables were found to affect *Intuitive evaluation* (see table 6.13). Age was found to be marginally significant (p = .05) however no significant post-hoc differences were found.

Table 6.13 *One-way ANOVA of the effect of socio-demographics on Intuitive evaluation*

	Gender	Age	Level of education	Social Class
intuitive evaluation	$F(1,951) = 2.81$, $p = .09$	$F(5,947) = 2.24$, $p = .05$	$F(3,949) = 0.48$, $p = .70$	$F(4,948) = 1.41$, $p = .23$

Gender and age were found to affect *Deliberate evaluation, Overall attitude* and *Acceptance.* Specifically, men expressed significantly more positive *Deliberate evaluation, Overall attitude* and *Acceptance* of products containing protein extracted from beef offal than women (see Tables 6.14, 6.15, 6.16). Aging was found to affect negatively *Deliberate evaluation, Overall attitude* and *Acceptance,* with most significant differences lying between the age groups 35-44 and 45-54 (see Tables 6.14, 6.15, 6.16). Participants' highest level of education was found to affect their *Acceptance* of products containing protein extracted from beef offal in a positive way (see Table 6.16). Finally, social class had a significant effect on participants' *Overall attitude* and *Acceptance* of food products containing protein extracted from beef offal; however, without providing evidence for a specific trend (see Table 6.15, 6.16).

Table 6.14 *One-way ANOVA and post-hoc analysis of the effect of socio-demographics on Deliberate evaluation*

		Tukey pairwise comparisons		Mean difference
Gender	$F(1, 951) = 15.50$, $\mathbf{p = .00}$	Males	Females	4.11 - 3.74 (*)
Age	$F(5, 947) = 4.86$, $\mathbf{p = .00}$	35-44	45-54	4.21 - 3.66 (*)
			55-64	4.21 - 3.64 (*)
Level of education	$F(3, 949) = 2.21$, $p = .08$			
Social Class	$F(4, 948) = 0.86$, $p = .49$			

Note: * Significance at .05 level.

Table 6.15*One-way ANOVA and post-hoc analysis of the effect of socio-demographics on Overall attitude*

		Tukey pairwise comparisons		Mean difference
Gender	$F(1, 951) = 22.08$, $\mathbf{p = .00}$	Males	Females	4.17 - 3.66 (*)
Age	$F(5, 947) = 3.53$, $\mathbf{p = .00}$	35-44	45-54	4.19 - 3.64 (*)
			55-64	4.19 - 3.67 (*)
Level of education	$F(3, 949) = 2.42$, $p = .06$			
Social Class	$F(4, 948) = 2.58$, $\mathbf{p = .03}$	C1	DE	4.09 - 3.71 (*)
		DE	F (LSD)	3.71 – 4.07 (*)

Note: * Significance at .05 level.

Table 6.16 *One-way ANOVA and post-hoc analysis of the effect of socio-demographics on Acceptance*

		Tukey pairwise comparisons		Mean difference
Gender	$F(1, 951) = 18.02$, $\mathbf{p = .00}$	Males	Females	4.12-3.68 (*)
Age	$F(5, 947) = 2.56$, $\mathbf{p = .03}$	35-44	45-54	4.14- 3.67(*)
Level of education	$F(3, 949) = 3.11$, $\mathbf{p = .03}$	Primary	Third(non-degree)	2.76- 3.98 (*)
			Third (degree or higher)	2.76- 4.00 (*)
		Secondary	Third(non-degree)	3.72 - 3.98 (*)
			Third (degree or higher)	3.72 - 4.00 (*)
Social Class	$F(4, 948) = 2.78$, $\mathbf{p = .02}$	C1	DE	4.10- 3.72 (*)

Note: * Significance at .05 level.

Pearson correlations reveal that all variables are significantly positively correlated (Table 6.17). Specifically, *Deliberate evaluation* shows strong and significant correlations with *Acceptance* and *Overall attitude.* These correlations are depicted in Figures 3a and 4a, and suggest the existence of a linear relationship between these

variables. *Intuitive evaluation* shows medium but significant correlation with *Deliberate evaluation, Overall attitude* and *Acceptance.* While there is evidence of a linear trend for the above mentioned correlations, the predictive power is very poor as shown by the low R^2 (Fig. 6.5, 6.3c, 6.4b). Finally, *Acceptance* shows strong and significant correlations with *Overall attitude* and a linear relationship is observed (Fig. 6.3b)

Table 6.17 *Correlations among main variables*

	deliberate evaluation	overall attitude	intuitive evaluation
Acceptance	.84** (b)	.85** (b)	.31** (a)
overall attitude	.87** (b)	1	.32** (a)
intuitive evaluation	.33** (a)	.32** (a)	1

Note: **Significance: 0.01

(a) = medium correlation, (b) = strong correlation

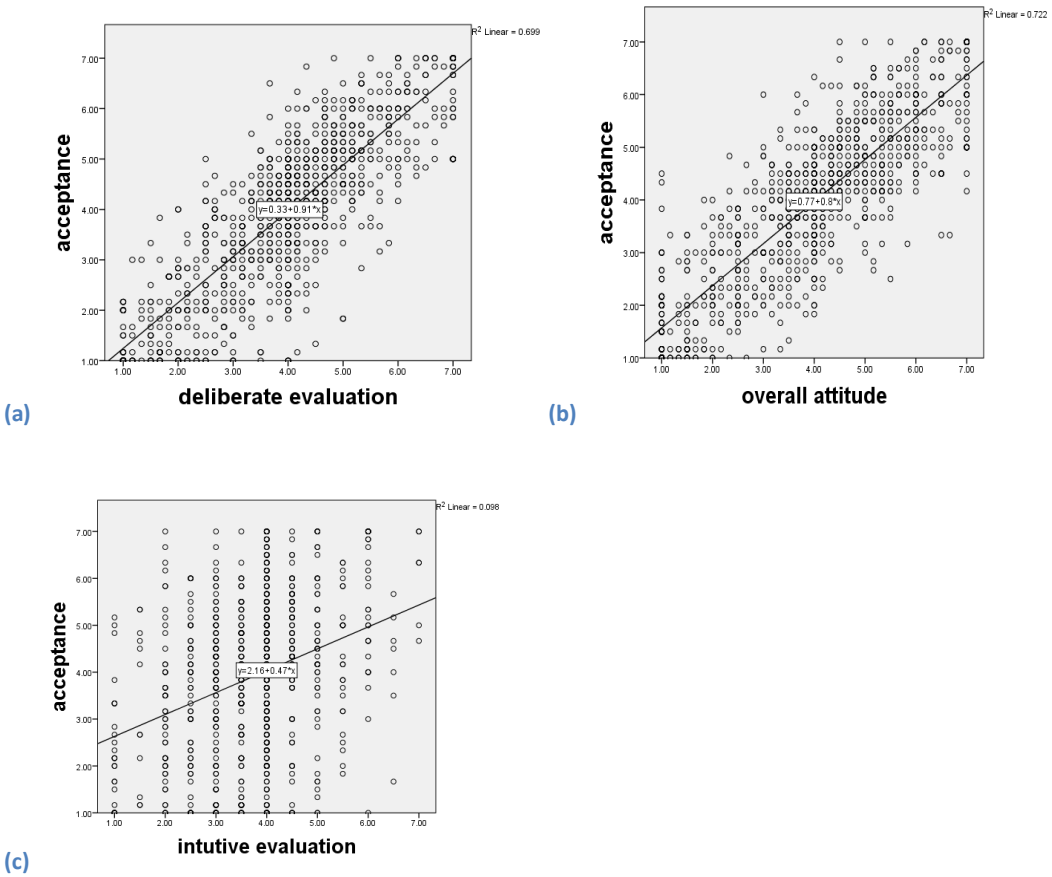


Figure 6.3 *Scatter plots of acceptance and deliberate evaluation, overall attitude and intuitive evaluation.*

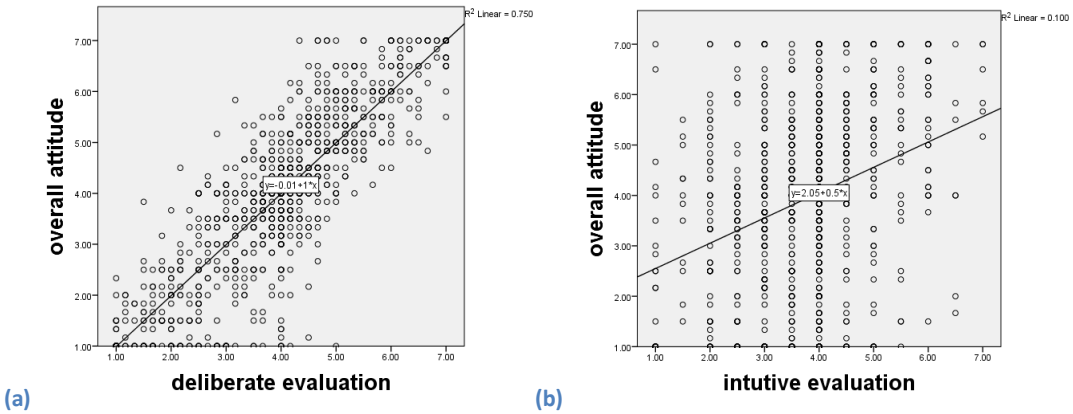


Figure 6.4 *Scatter plots of overall attitude and deliberate evaluation and intuitive evaluation*

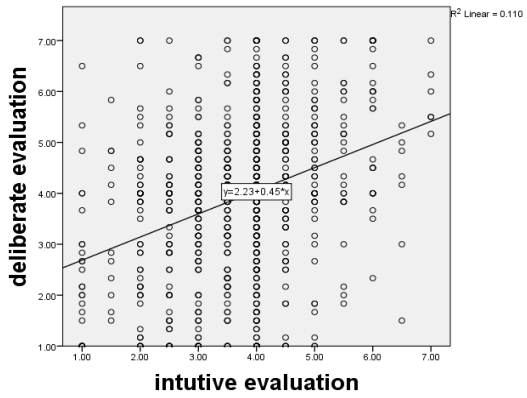


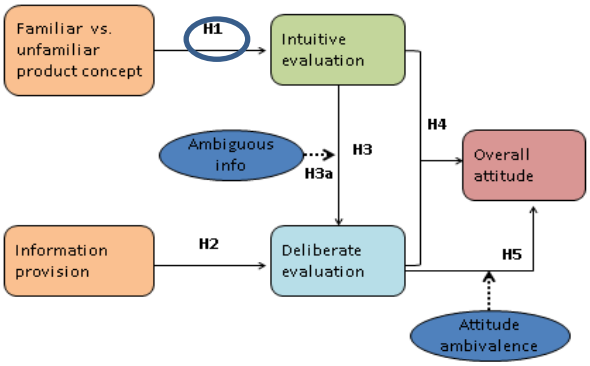
Figure 6.5 *Scatter plot of deliberate evaluation and intuitive evaluation*

While there are observed correlations between the variables, at this point we have no inferences about causality. For example, although we can notice that as *Overall attitude* towards food products containing protein extracted from beef offal increases, *Acceptance* towards these products increases also, we cannot conclude that a more positive *Overall attitude* causes higher *Acceptance*. However, the examination of these bivariate correlations is useful and provides support for further investigation. The following section will examine the hypotheses of specific relationships and effects that were developed in the Methodology Chapter (see section 4.7)

6.3 Hypotheses testing

In this section the specific hypotheses developed in the methodology chapter are tested. All hypotheses are presented in the conceptual model, and tested separately under corresponding heading.

Hypothesis 1: Effect of familiarity on Intuitive evaluation



H1: Individuals who are exposed to an image of a familiar product concept are more likely to have more positive intuitive evaluation than people who are exposed to unfamiliar product concepts.

As discussed in the previous chapter, the selection of familiar and unfamiliar product concepts was based on a pre-test, where participants expressed their perceived familiarity with product concepts containing protein extracted from different beef offal sources.

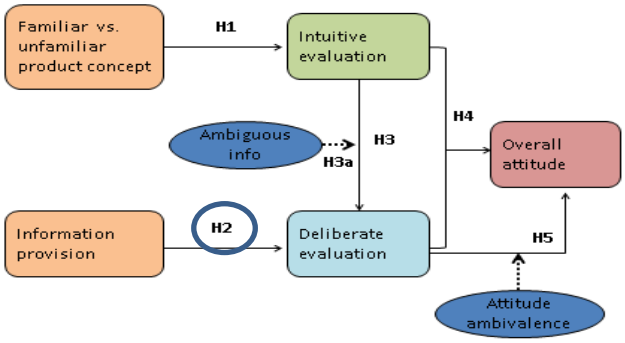
The scores for *Intuitive evaluation* of familiar product concepts (containing protein extracted from liver) did not vary significantly from that for unfamiliar product concepts (containing protein extracted from lung) (n= 480, M=3.78, SD=1.07 and n=473, M=3.70, SD=1.06, respectively). A one-way ANOVA was used to determine if *familiarity* with the product concept containing protein extracted from beef offal affects the *Intuitive evaluation* of these products. The results obtained show that the mean *Intuitive evaluation* was not significantly different for factor "*familiarity*" (see table 6.18). Therefore, our hypothesis that participants' *Intuitive evaluation* of product concepts containing protein extracted from beef offal would be affected by *familiarity* is not supported by the data.

Table 6.18 *One-way ANOVA analysis of intuitive evaluation score explained by factor familiarity*

	Sum of Squares	*df*	Mean Square	*F*	*p-value*
Between Groups	1.66	1	1.66	1.46	.23
Within Groups	1081.28	951	1.14		
Total	1082.94	952			

Note: * Significance at .05 level.

Hypothesis 2: Effect of information on Deliberate evaluation



H2: Individuals who are provided with either benefit or ambiguous information are more likely to have a more positive deliberate evaluation of product concepts containing protein extracted from beef offal than people who are provided with no information.

The mean obtained from the *Deliberate evaluation* of product concepts when *benefit information* was provided (*M*=4.24, *SD*= 1.51) was higher than the mean of *Deliberate evaluation* of product concepts when *no information* was provided (*M*=3.54, *SD*= 1.40) or when *ambiguous info* was provided (*M*=4.02, *SD*= 1.39). ANOVA analysis shows that there was a significant effect of *information* on *Deliberate* evaluation (see Table 6.19). Furthermore, planned contrasts revealed that providing information, either benefit or ambiguous, lead to a significantly more positive *Deliberate evaluation* compared to when no information was provided, $t(950) = 6.03$, $p < .05$ (1-tailed). Therefore, H2 is supported by the data.

Table 6.19 *One-way ANOVA analysis of deliberate evaluation score explained by factor information*

	Sum of Squares	*df*	Mean Square	*F*	*p-value*
Between Groups	80.22	2	40.11	19.49	.00
Within Groups	1954.78	950	2.06		
Total	2035.01	952			

Note: * Significance at .05 level.

Having established this relationship, i.e. that providing participants with *benefit information* about the food products containing protein extracted from beef offal lead to a significantly more positive *Deliberate evaluation* towards these products, further analysis was conducted in order to examine if this relationship is moderated by *familiarity* with the product concept (see Fig. 6.6). The aim of this further analysis was to examine if the effect of *benefit information* on *Deliberate evaluation* changes as a function of *familiarity* with the product concept.

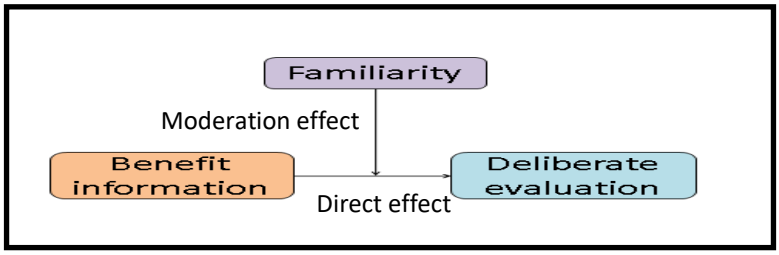


Figure 6.6 *Schematic representation of the moderation effect of familiarity in the relationship between benefit information provision and deliberate evaluation*

Univariate Analysis of Variance was conducted with *information* and *familiarity* as the independent variables and *Deliberate evaluation* as the dependent. The results show that there was a significant main effect of *familiarity* on *Deliberate evaluation* (see Table 6.20). Participants' *Deliberate evaluation* for *familiar* product concepts was significantly more positive than that for unfamiliar product concepts (*MD* = 0.24, p = .01). However, the interaction effect of *benefit information* and *familiarity* on *Deliberate evaluation* was found to be insignificant (see Table 6.20). This indicates that *benefit information* affected participants' *Deliberate evaluation* of products containing protein extracted from beef offal similarly (in the same direction and significance) for both familiar and unfamiliar product concepts (Fig. 6.7)

Table 6.20 *Anova table of the effects of Information, Familiarity and their interaction on Deliberate Evaluation*

	Sum of Squares	df	Mean Square	F	p-value	Partial η^2
Corrected Model	97.41[a]	5	19.48	9.52	.00	.05
Intercept	14730.59	1	14730.58	7199.57	.00	.88
Information	80.66	2	40.33	19.71	.00	.04
Familiarity	15.82	1	15.82	7.73	.01	.01
Information*familiarity	1.31	2	.65	.32	.72	.00
Error	1937.59	947	2.04			
Total	16768.75	953				
Corrected Total	2035.00	952				

a. R Squared = .030 (Adjusted R Squared = .027), Note: *Significance at .05 level.

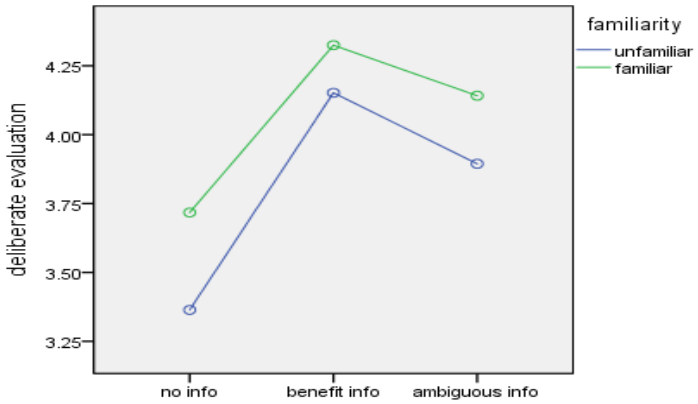
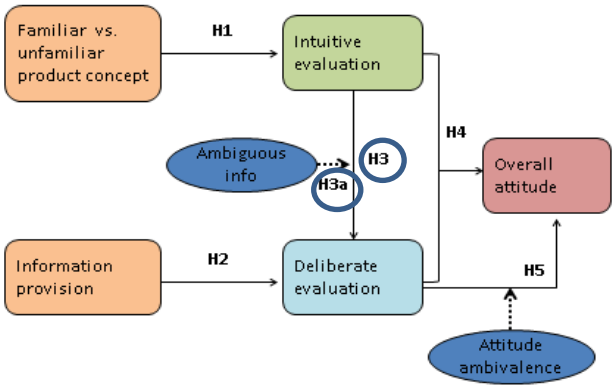


Figure 6.7 *Graph of interaction effect of familiarity and information on deliberate evaluation*

Hypothesis 3: Effect of Intuitive evaluation on Deliberate evaluation



H3: The more positive the intuitive evaluation the more positive the deliberate evaluation will be.

*H3a: For individuals who are exposed to **ambiguous** information, it is more likely that their deliberate evaluation will be determined by intuitive evaluation in accordance with HSM's bias hypothesis.*

A simple linear regression was conducted to predict participants' *Deliberate evaluation* of product concepts containing protein extracted from beef offal based on their *Intuitive evaluation*. The regression model overall predicts *Deliberate evaluation* significantly well, F (1,951) = 117.30, p = .00 (see Table 6.21). An R^2 of .11 suggests that *Intuitive evaluation* account for 11% of the variation in *Deliberate evaluation*. Despite the low degree of correlation between *Deliberate evaluation* and *Intuitive evaluation*, this analysis supports H3: a more positive intuitive evaluation of product concepts containing protein extracted from beef offal causes a more positive deliberate evaluation towards these products.

Table 6.21 *Simple regression model predicting deliberate evaluation by Intuitive evaluation*

	Beta	*t*	*p-value*	R^2	*Df*	*F*
				.11	(1,951)	117.30
Intuitive evaluation	.33	10.8	.00			

It was further hypothesised that for those individuals who are exposed to ambiguous information, their *Deliberate evaluation* would be more strongly affected by their *Intuitive evaluation*. A multiple regression was conducted with *Deliberate evaluation* as the dependent variable and *Intuitive evaluation*, *ambiguous information* and the interaction term *Intuitive evaluation*ambiguous info* as the independent variables. The model predicts *Deliberate evaluation* significantly well, F(3,949) = 39.72, p = .00, R^2 = .11. However, the interaction effect was found to be insignificant (see Table 6.22). This indicates that participants' *Intuitive evaluation* of products

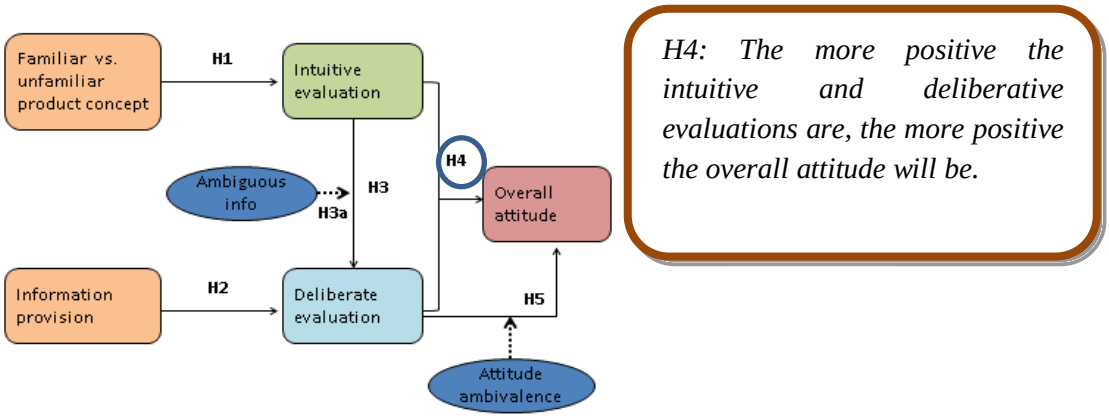
containing protein extracted from beef offal affected their *Deliberate evaluation* of these products similarly when ambiguous information was or was not provided to them.

Table 6.22 *Multiple regression model predicting deliberate evaluation by Intuitive evaluation, ambiguous information and their interaction*

	Beta	*t*	*p- value*	R^2	*Df*	*F*
			.00	.11	(3,949)	39.72
Intuitive evaluation	.35	9.53	.00			
Ambiguous info	.13	1.13	.26			
Intuitive evaluation*Ambiguous info	-.10	-.88	.38			

Note: * Significance at .05 level.

Hypothesis 4: Effect of Intuitive and Deliberate evaluations on Overall attitude



A multiple regression was conducted to predict *Overall attitudes* towards product concepts containing protein extracted from beef offal based on *Intuitive evaluation* and *Deliberate evaluation*. The regression model showed that both *Intuitive evaluation* and *Deliberate evaluation* were good predictors of *Overall attitudes*: $F(2,950) = 1429.99$, $p = .00$, $R^2 = .87$. The big effect size indicates that 87% of the variance in participants' *Overall attitudes* towards the food product containing protein extracted from beef offal is explained significantly by both *Intuitive* and *Deliberate evaluation* of these products. *Deliberate evaluation* ($\beta = .85$) was found to have a greater contribution on *Overall attitudes* than *Intuitive evaluation* ($\beta = .03$).

These results confirm H4: the more positive the intuitive and deliberative evaluations are, the more positive the overall attitude will be.

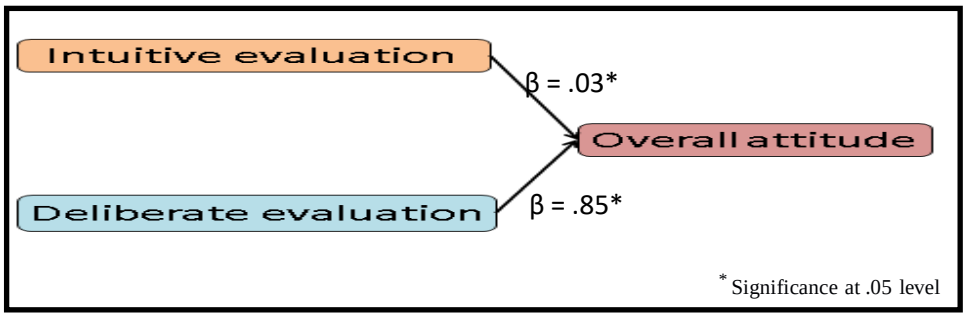


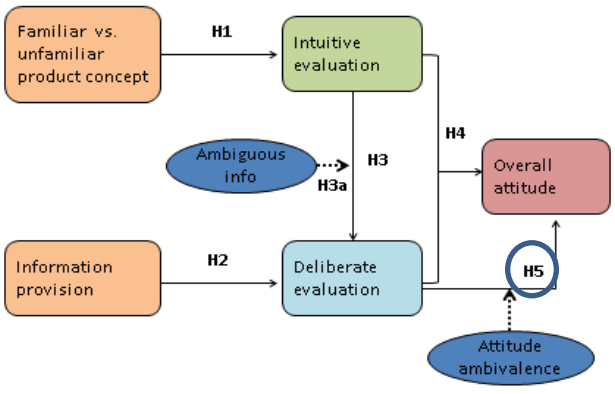
Figure 6.8 *Multiple regression analysis predicting Overall attitude by Intuitive evaluation and Deliberate evaluation*

Table 6.23 *Multiple regression results predicting overall evaluation by Intuitive evaluation and Deliberate evaluation*

	Beta	*t*	*p-value*	R^2	*Df*	*F*
			.00	.87	(2,950)	1429.99
Intuitive evaluation	.03	1.94	.05			
Deliberate evaluation	.85	49.78	.00			

Note: * Significance at .05 level.

Hypothesis 5: Effect of Deliberate evaluations on Overall attitude considering attitude ambivalence



H5: The more ambivalent the attitudes, the greater will be the effect of deliberate evaluation on overall attitudes

As it was previously shown, participants' *Deliberate evaluation* of food products containing protein extracted from beef offal has a significant and positive effect on their *Overall attitude* towards these products (see H4). Here, it is hypothesised that the strength of this relationship will be moderated by the level of *ambivalence* that

someone is experiencing (see Fig. 6.9). Specifically, it is hypothesised that the more ambivalent the participants feel, the stronger will be the effect of *Deliberate evaluation* on *Overall attitude.*

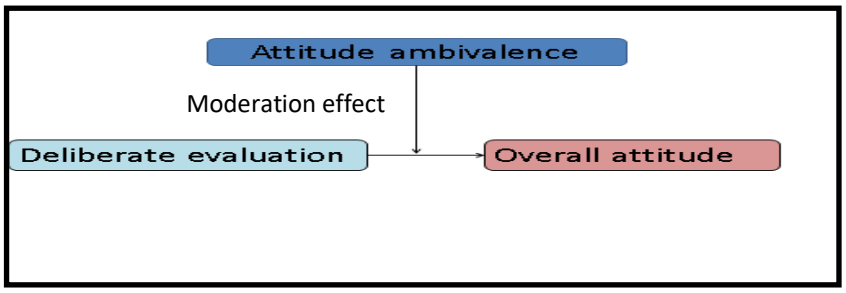


Figure 6.9 *Schematic representation of the moderation effect of attitude ambivalence in the relationship between Deliberate evaluation and Overall attitude*

A multiple regression was conducted to predict *Overall attitude* towards food products containing protein extracted from beef offal based on *Deliberate evaluation, Attitude ambivalence* and the interaction of *Deliberate evaluation and Attitude ambivalence*. The Direct effect regression model overall predicts *Overall attitude* significantly well, F (3, 952) = 955.67, p = .04, R^2 = .75. However, the effect of the interaction term was found insignificant, indicating that participants' *Deliberate evaluation* of food products containing protein extracted from beef offal affected their *Overall attitude* towards these products regardless of experienced ambivalence (see Table 6.24). Therefore, H5 is not supported by the data.

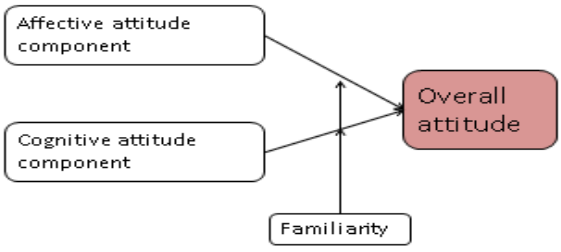
Table 6.24 *Multiple regression model predicting Overall attitude based on Deliberate evaluation, Attitude ambivalence and their interaction*

	Beta	*t*	*p-value*	R^2	*Df*	*F*
			.04	.75	(3, 952)	955.67
Deliberate evaluation	.78	13.82	.00			
Attitude ambivalence	-.09	-2.32	.02			
Deliberate evaluation*Attitude ambivalence	.12	1.66	.09			

Note: * Significance at .05 level.

H5 derived from theory (see section 4.2.5) and explored the interaction effect of Deliberate evaluation and Attitude ambivalence on Overall attitudes, however without accounting for the possible main effect of Intuitive evaluation. Since Intuitive evaluation was found to affect Overall attitude (see H4), a new regression model was used in order to test the interaction effect of Deliberate evaluation and Attitude ambivalence on Overall attitudes including this time Intuitive evaluation. This further step was undertaken in order to avoid omitted-variable bias. The new regression model (F (4, 948) = 719.75, p = .00) also showed that the interaction effect of Deliberate evaluation and Attitude ambivalence on Overall attitudes was not significant (p = .11).

Hypothesis 6: Effect of affective and cognitive attitude component on Overall attitude considering familiarity with the product concept



H6: Affect will have a relatively stronger effect on overall attitude for unfamiliar compared to familiar product concepts, whereas cognition will have a weaker effect on overall attitude for unfamiliar than for familiar product concepts.

A multiple regression was conducted to examine the effect of the hypothesized variables on *Overall attitude* (Fig. 9). The regression model predicts *Overall attitude* significantly well, $F(5,947) = 926.90$, p = .00, $R^2 = .83$. However, the interaction effect of *familiarity* and *affective attitude* on *Overall attitude* was found insignificant ($p > .05$) (see Table 6.25). Therefore, participants' *affective attitude* towards the product concepts containing protein extracted from beef offal affected their *Overall attitude* in the same way when the product concept was familiar or unfamiliar. The interaction effect of *familiarity* and *cognitive attitude* was also found insignificant ($p > .05$) suggesting that participants' *cognitive attitude* towards the product concepts containing protein extracted from beef offal affected their *Overall attitude* in the

same way when the product concept was familiar or unfamiliar (see Table 6.25). Therefore, H6 is not supported by the data.

While the above hypothesis is rejected, an interesting result arose in regard to which attitude component has the strongest effect on *Overall attitude*. Specifically, *affective attitude component* was found to have a greater contribution in *Overall attitude* (β = .62, *p* = .00) than *cognitive component* (β = .33, *p* = .00). This means that increase in individuals *affective attitude component* towards the food products containing protein extracted from beef offal has a greater positive effect on their *Overall attitude* than an increase in *cognitive attitude component.*

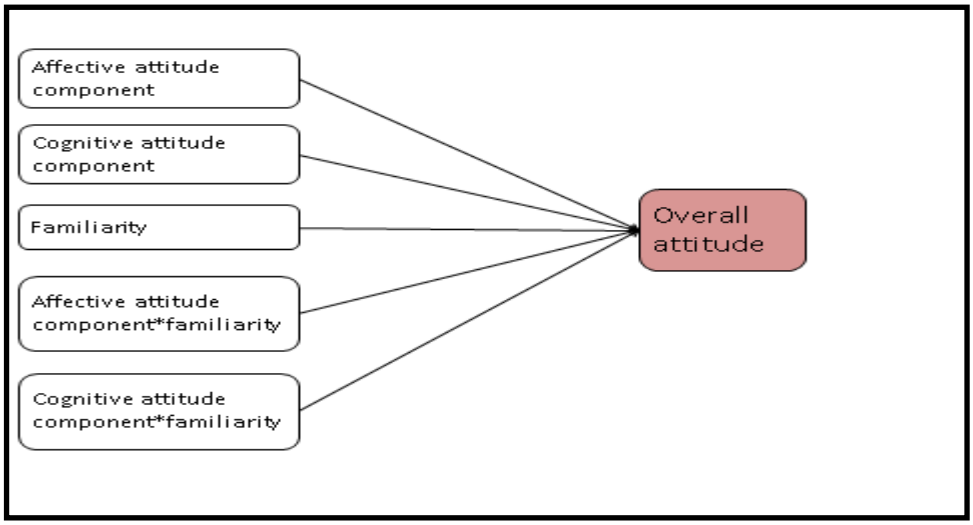


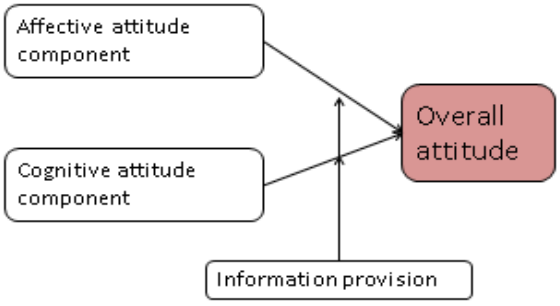
Figure 6.10 *Multiple regression analysis of hypothesized variables on Overall attitude (1)*

Table 6.25 *Multiple regression model predicting Overall attitude by: Affective attitude component, Cognitive attitude component, Familiarity, the interaction of Affective attitude component and Familiarity, and the interaction of Cognitive attitude component and Familiarity.*

	Beta	*t*	*p- value*	R^2	*df*	*F*
			.00	.83	(5,947)	926.90
Affective attitude component	.62	16.25	.00			
Cognitive attitude component	.33	8.99	.00			
Familiarity	.03	.71	.48			
Affective attitude component * Familiarity	- .07	-.79	.43			
Cognitive attitude component * Familiarity	.04	.45	.65			

Note: * Significance at .05 level.

Hypothesis 7: Effect of affective and cognitive attitude component on Overall attitude, considering information provision



H7: Cognition will have a relatively stronger effect on overall attitude for individuals provided with either benefit or ambiguous information compared to individuals provided with no information, whereas affect will have a stronger effect on overall attitude for individuals provided with no information compared to individuals provided with either benefit or ambiguous information.

A multiple regression was conducted to examine the effect of hypothesized variables on *Overall attitude* (Fig. 10). The regression model predicts *Overall attitude* significantly well, $F(8,944) = 585.66$, $p = .00$, $R^2 = .83$. The interaction between *cognitive attitude component* and *information* has a significant effect on *overall attitude* towards food products containing protein extracted from beef offal; *overall attitude* is more positive when *ambiguous information* is provided. The interaction between *affective attitude component* and *information* has a significant effect on *overall attitude* towards food products containing protein extracted from beef offal, showing that *overall attitude* is more positive when *no information* is provided compared to when *benefit* or *ambiguous information* is provided (see Table 6.26).

The above results partly partially confirmed H7 and showed under which information conditions affective or cognitive attitude components are better predictors of participants' overall attitudes towards food products containing protein extracted from beef offal.

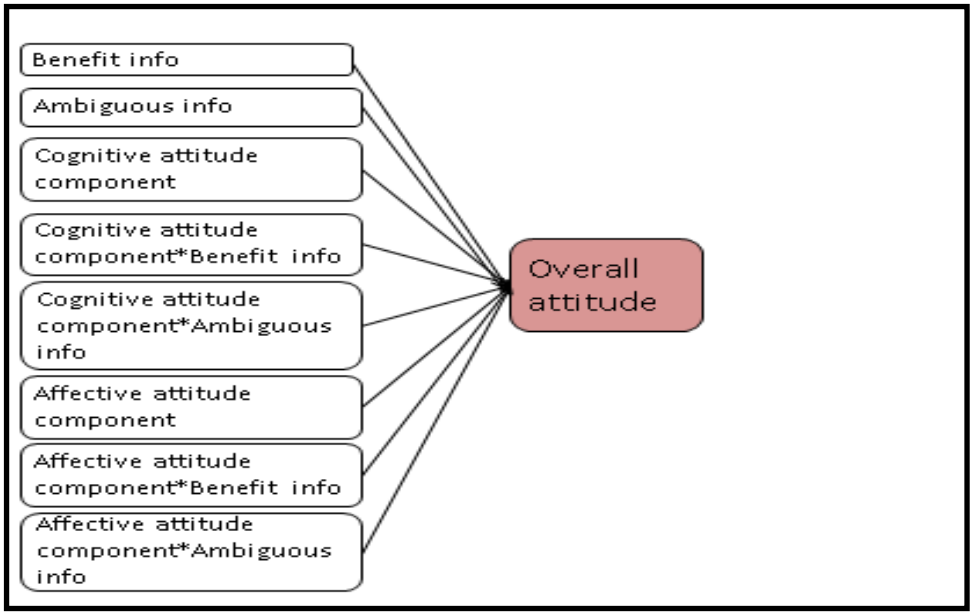


Figure 6.11 *Multiple regression analysis of hypothesized variables on Overall attitude (2)*

Table 6.26 *Multiple regression model predicting Overall attitude by: Information, Cognitive attitude component, Affective attitude component, the interaction of Cognitive attitude component and information, and the interaction of Affective attitude component and information*

	Beta	*t*	*p-value*	R^2	*df*	*F*
			.00	.83	(8,944)	585.66
Benefit info	.09	1.99	.04			
Ambiguous info	.05	1.09	.27			
Cognitive attitude component	.26	5.68	.00			
Cognitive attitude component * Benefit info	.14	1.40	.16			
Cognitive attitude component * Ambiguous info	.24	2.42	.02			
Affective attitude component	.69	15.64	.00			
Affective attitude component * Benefit info	-.22	-2.16	.03			
affective attitude component * Ambiguous info	-.27	-2.60	.01			

6.4 Linear multiple regressions predicting Overall attitudes and Acceptability

The hypotheses examined earlier explored the impact of specific factors on participants' attitudes towards food products containing protein extracted from beef offal. Besides the central hypotheses, in an effort to explore further the interrelationships between the factors that influence participants' attitudes of food products containing protein extracted from beef offal, a multiple regression model predicting *Overall attitude* based on socio-psycho-demographics, attitude components and the experimental conditions was conducted. It was decided to omit attitude formation processes measures (i.e. intuitive and deliberate evaluations) due to risks of multicollinearity. Affect Misattribution Procedure (i.e. intuitive evaluation measure) is likely to capture affective reactions (Trendel and Werle, 2015) and therefore might lead to an overlap with the affective attitude component variable.

While there are no indications based on the literature review that socio- demographic variables will have an influence on participants' attitudes towards food products containing protein extracted from beef offal, they are entered in the model since initial exploratory analysis had shown some significant effects of gender, age and social class on overall attitudes. Moreover, food neophobia is a personality trait that has been specifically related to the food research area and even more to research on new foods. It is expected that consumers with high levels of food neophobia will have more negative attitudes towards the food products containing protein extracted from beef offal. Finally, attitude research indicates that consumers might express goal-congruent attitudes when the relevant attitudes are activated. Given the context of the study, i.e. references to sustainability and health benefits of protein, it is expected that participants' attitudes to food and environment and attitudes towards the healthiness of foods will influence their overall attitudes towards food products containing protein extracted from beef offal. The effect of all above mentioned factors on participants' overall attitudes need to be examined in relation to experimental conditions. Therefore, familiarity with the food products and information provision were also entered as dependent variables.

The analysis showed that *Overall attitude* was well predicted $F(17,935)= 276.62$, $p = .00$, $R^2= .83$, mainly by affective attitude component, cognitive attitude

component and attitudes to food and environment (see Table 6.27). Socio-demographics, food neophobia, attitudes towards healthiness of foods and experimental conditions were not found to have a significant effect on participants' overall attitudes towards the food products containing protein extracted from beef offal.

Table 6.27 *Regression model predicting Overall attitude*

	Overall attitude		
Independent variables in equation	**Beta**	**t**	**p**
Gender (0 male, 1 female)	-.01	-1.15	.24
Age (yrs)	-.02	-1.62	.10
Highest level of education (0 =lower level)			
Secondary	-.05	-.69	.48
Third non-degree	-.04	-.61	.54
Third degree or higher	-.03	-.46	.64
Social Class (0 =lower level)			
AB	-.04	-.86	.38
C1	-.04	-.82	.40
C2	-.01	-.33	.73
DE	-.05	-1.01	.31
Attitudes towards healthiness of food	-.02	-1.31	.18
Food neophobia	-.02	-1.52	.12
Attitudes to food and environment	.04	2.55	**.01**
Affective attitude component	.59	21.12	**.00**
Cognitive attitude component	.33	11.75	**.00**
Familiarity (-0.5 = unfamiliar, 0. 5= familiar)	.00	.20	.83
Information provision (0 = no info)			
Benefit info	.02	1.42	.15
Ambiguous info	.02	1.26	.20
	$F(17,935)= 276.62$, $p = .00$, $R^2 = .83$		

6.5 Conclusion

This chapter began with a descriptive section of participants' burger and sausage consumption, revealing that sausages are consumed more frequently than burgers. These frequencies were further explored by socio-demographic factors showing some interesting relationships. Specifically, males were found to consume burgers

and sausages more frequently than women. Moreover, older participants (45 yrs+) reported eating burgers less frequently than younger participants (18-44 yrs), whereas, in regard to sausage consumption, age did not show any difference. Also, participants with higher education level reported consuming sausages less frequently than participants with lower education level, whereas no difference in burger consumption was found in respect to participants' level of education. An interesting result arose regarding participants' social class and reported consumption levels; participants belonging to higher social classes reported eating burgers more frequently but sausages less frequently than participants coming from lower social classes. The effect of socio-demographic factors on measured variables followed, showing that different demographic groups differ in the way they form their deliberate evaluations, overall attitudes and acceptance towards the product concepts containing protein extracted from beef offal. Gender and age were found to affect all measures with men expressing more positive views and older participants expressing more negative views. This overview of consumption trends and socio- demographic analysis was followed by the hypotheses testing.

In terms of underlying processes, it was shown that participants relied on both intuitive and deliberate evaluation processes in order to form their overall attitudes towards the food products containing protein extracted from beef offal. While both processes were present, deliberate process was found to dominate participants' attitude formation. This suggests that participants engaged in a conscious and analytic process in order to form their attitudes towards the food products containing protein extracted from beef offal. As intuitive process relies strongly on previously experiences; a possible lack of participants' experience with offal products could explain their reliance on deliberate process in order to form their attitudes.

In accordance with the theory, participants' attitudes towards the food products containing protein extracted from beef offal were jointly determined by affect and cognition. However, the results show that there was a stronger influence by affective factors. Affect can be relatively more intuitive or more deliberate. Given that participants relied more on deliberate reasoning to form their attitudes, affect in this case possibly reflects an elaborate affect in the form of conscious emotions in respect

to the food products and not immediate affect in the form of disgust and "gut" feelings.

With respect to product familiarity influence on attitudes towards beef offal extracted protein, participants expressed a more positive deliberate evaluation towards familiar product concepts comparing to unfamiliar. However, participants' intuitive evaluation was not affected by familiarity with the product concepts. With regard to the effect of information provision on attitudes, participants who received information about the health and environment benefits of protein extracted from beef offal for human consumption expressed a more positive deliberate evaluation.

The last part of the analysis (see section 6.4) showed that when controlling for study important factors, participants' overall attitudes towards food products containing beef offal were mainly influenced by affect and cognition, and attitudes to food and environment. When participants' overall attitudes were examined only by socio-demographic factors, significant effects of gender, age and social class were found. However, when socio-demographics were analysed combined with other factors, they showed no effect on participants' overall attitudes, reflecting the complex interplay of the multiple factors that shape individuals' attitudes.

A detailed discussion of the results is undertaken in the following chapter.

7 Conclusions and recommendations

7.1 Introduction

The primary objective of this research was to develop a conceptual understanding of Irish consumers' attitudes to incorporating protein extracted from beef offal into food products. The research question that guided this study was:

What attitude processes dominate attitude formation towards food products containing protein extracted from beef offal and are the resulting attitudes more affective or cognitive in nature?

Additional research questions, deriving from this core question, were included:

- *Are attitudes towards food products containing protein extracted from beef offal influenced by affect and/or cognition?*
- *In terms of underlying processes, to what extent can attitudes towards food products containing protein extracted from beef offal be predicted by intuitive and/or deliberate evaluations?*
- *Does information influence attitudes towards food products containing protein extracted from beef offal?*
- *Does product familiarity influence attitudes towards food products containing protein extracted from beef offal?*

This chapter begins with a discussion on the conclusions drawn from the results of the consumer survey presented in the previous chapter. This discussion is centred on the research questions and reflects on themes and constructs that describe the findings or interpret some aspects of the findings. The key outcomes of this research are contextualised with the findings from other related research in order to help the interpretation of the research findings and provide further insight. Following this, the research limitations of this study are considered along with directions for further research. The chapter ends with recommendations that inform commercial applications in the context of developing food products containing protein extracted from beef offal.

7.2 Research conclusions

7.2.1 Affective and cognitive influences on attitude towards food products containing protein extracted from beef offal

In addressing the research question about whether participants' attitudes towards food products containing protein extracted from beef offal are more affective or cognitive in nature, this study explored the simultaneous effects that cognition and affect had on participants' attitudes. Participants were asked to evaluate burgers and sausages containing protein extracted from beef offal; the results indicate that their attitudes towards these products represented an evaluative integration of both cognition and affect. This result is consistent with the literature in the area of attitudes which suggests that purely affective or cognitive attitudes are unlikely as both cognition and affect play intertwined roles in forming overall attitudes (Crano and Prislin, 2006, Edwards, 1990). However, in the context of this study, it was found that participants relied primarily on affect rather than on cognition to form their overall evaluations toward the food products containing protein extracted from beef offal. This result is in accordance with ample empirical evidence which supports conclusions that food decisions and attitudes are largely driven by affective reactions probably due to the hedonic nature of food (de Liver et al., 2005, Lowe and Butryn, 2007).

An important point of interest was to examine if the role of affect and cognition on participants' overall attitudes would differentiate as a function of participants' familiarity with the product concepts. Familiarity with the products was addressed through the inclusion of one more familiar (i.e. beef liver) and one more unfamiliar (i.e. beef lung) protein source into the product carriers (i.e. burgers and sausages). The results showed that for both familiar and unfamiliar product concepts participants relied more on affect than on cognition in order to form their attitudes. This result concurs with previous research which has shown that for unfamiliar attitude objects affect contributes more strongly than cognition to attitude formation (Slovic et al., 2007, Bechara and Damasio, 2005, Scheufele and Lewenstein, 2005). In addition, given that cognition also contributed to participants' overall attitudes to the unfamiliar product concepts, this study demonstrated that although the default is

to rely on affect when evaluating an unfamiliar attitude object, individuals were able to draw also on some cognitive reasoning when faced with the unfamiliar product concept. This view aligns with the constructionist perspective on attitude formation suggesting that individuals are able to construct cognitive inferences towards unfamiliar attitude objects by creating new connections between the unfamiliar attitude object and existing knowledge structures (Fazio, 2007, Schwarz, 2007).

Furthermore, it was shown that information provision regarding the health and environmental consequences of consuming food products containing protein extracted from beef offal interacted with participants' both affective and cognitive responses. This finding echoes work discussed by previous studies, such as Crano and Prislin (2006) and Cunningham and Zelazo (2007) who have supported an argument that information provision seems to activate both cognitive and affective reactions. Specifically, when no information was provided, the affective attitude component was found to influence participants' attitudes more strongly. This adds to previous research suggesting that in cases when individuals lack specific knowledge and information towards the attitude object, it is more likely that they will rely more on affective associations to form their attitudes (Van Giesen et al., 2015, Lee et al., 2005). Providing participants with either benefit or ambiguous information regarding the health and environmental consequences of consuming food products containing protein extracted from beef offal resulted in a weaker influence of affect on their attitudes and in less positive overall attitudes. Moreover, ambiguous rather than benefit information interacted with participants' cognition resulting in higher overall attitudes. This is not surprising, as in some circumstances, two-sided arguments can be more effective on attitude formation than one sided argument (Bohner et al., 2003, Price et al., 2015) as they can be associated with higher perceptions of source credibility and higher perceived product quality (Kim, 2016, Eisend, 2010)

One possible explanation for participants' less positive attitudes occurring through the interaction of affect and information provision might mean that the information provided in this study was cognition based. Research has shown that given information should match the attitude base, be it affectively or cognitively based, in order to have a positive effect on attitudes (Dubé and Cantin, 2000, Zajonc, 1980, Edwards, 1990, Fabrigar and Petty, 1999). Given that participants' attitudes were

found to be primarily affectively based, this could mean that the content of provided information contributed to stronger cognitive associations reducing the effect of affect on overall attitudes.

Another potential reason explaining why information presenting these products as healthy and sustainable did not lead to more positive overall attitudes when interacted with affect, could be psychological reactance. Psychological reactance is a social psychological theory that explains human behaviour when people perceive a threat to their sense of personal freedom and choice (Brehm, 1966). In the consumer behaviour context, this means consumers actively do the opposite of the recommendations they feel at odds with (Burger, 1999, de Beukelaar et al., 2019). It is possible that information promoting the health benefits of burgers and sausages was perceived as unjustified by the participants, as burgers and sausages are not products associated with a health image. Empirical research has shown that health claims are more accepted on products that already have a healthy image (e.g (Bech-Larsen and Grunert, 2003, Siegrist et al., 2008, Lähteenmäki et al., 2010, Dean et al., 2007). Moreover, incorporating protein extracted from beef offal in burgers and sausages might form a threat to some participants, as these products are already a "source of protein". In a comparable context, when focus groups carried out in Finland, France and the Netherlands were introduced to the prospect of enhancing flavonoid content in fruit and vegetables, they questioned the proposal to boost the healthiness of something that already is regarded as healthy by nature (Lampila et al., 2009). Henchion et al., (2016) qualitative research found similar expressions of suspicions exist when they investigated Irish consumers' evaluations of hypothetical food products containing ingredients derived from offal and produced through a range of food processing technologies. More specifically, some focus group participants questioned the perceived necessity of incorporating highly processed ingredient into a fresh meat and seemed to be more open to consuming offal extracted ingredients in other forms such as supplements and capsules.

In conclusion to this section, it is clear that affective inferences play a more significant role in participants' attitudes towards food products containing protein extracted from beef offal However, individuals do draw on cognitive reasoning also, i.e. they do not rely only on affect to form their attitudes.

7.2.2 Intuitive and deliberate processes leading to attitudes towards food products containing protein extracted from beef offal

The second major interest of this study was related to exploring the underlying processes that lead to attitude expression. Two types of consumer evaluations of food are distinguished: intuitive and deliberate. Intuitive evaluation is assumed to be immediate, unintentional and without much conscious awareness, while deliberate evaluation is consciously controlled and arises from intentional and thoughtful consideration (Kruglanski and Gigerenzer, 2011, Pachur and Spaar, 2015, Marquardt and Hoeger, 2009, Olson and Kendrick, 2011). This study used both conscious and unconscious measures to explore participants' intuitive and deliberate evaluations.

Participants' both intuitive and deliberate evaluations towards the burgers and sausages containing protein extracted from beef offal, predicted overall attitudes towards these products. Moreover, it was shown that intuitive and deliberate evaluations worked in the same direction to form participants' overall attitudes. This result may be explained within the context of attitude ambivalence discussed earlier (see section 4.2.5). It is possible that the distinct attribute of these new products (i.e. offal extracted protein) was particularly salient to participants when asked to evaluate the products, leading to ambivalence. Empirical research has shown that ambivalence is related to effortful deliberation (e.g. Clark et al., 2008; Nordgren et al., 2006). Therefore, it is possible that participants relied more on an analytic process in order to form attitudes towards a food product for which they did not hold a pre-defined and clear understanding.

Another explanation about the fact that deliberate evaluation was found to be better predictor of participants' overall attitudes can be related to the differential role of intuitive and deliberate evaluation. Research has suggested a dissociation pattern, with intuitive evaluation influencing spontaneous choices and behaviours and deliberate evaluations influencing controlled choices (Richetin et al., 2007, Perugini, 2005, König et al., 2016). Given the nature of the survey, it is possible that participants intentionally relied more on an elaborate reasoning in order to arrive at an expressed overall attitude. Therefore, due caution should be given to the observed magnitude of the deliberate evaluation effect on overall attitudes.

Participants' perceived familiarity with the product concepts was found to influence their deliberate evaluations. Specifically, participants' deliberate evaluation was more positive when the burgers and sausages were presented to contain protein extracted from beef liver than from beef lung. Previous research in the food domain has underlined the important role of using familiar preparations in increasing liking, willingness to eat and acceptance of new foods (Pelchat and Pliner, 1995, Tuorila et al., 1998, Tuorila et al., 1994, Wansink, 2002, Hoek et al., 2011, Calantone et al., 2006). As evident in research conducted into the development of cultured meat and insect based foods, which are two areas comparable with the development of food products containing protein extracted from beef offal, consumers' preferences were positively influenced by high levels of perceived familiarity with the ingredient or the product (Verbeke, 2015, Schösler et al., 2012).

Participants who received benefit information about the health and environmental consequences of consuming food products containing protein extracted from beef offal expressed a more positive deliberate attitude towards these products. This result concurs with the most common information studies which support the argument that providing information on product benefits results in more positive evaluations. Information appears to be particularly important in influencing acceptability of new food products (e.g. insect based products) (Verneau et al., 2016). For example, in a recent study, Bekker et al. (2017) found that providing consumers with positive information about cultured meat increases self-reported attitudes towards these products.

In conclusion, this research indicates that participants' deliberate evaluations best predict the overall attitudes towards food products containing protein extracted from beef offal. However, the possible impact of the survey methodology on consumer responses needs to be considered, as it is unlikely that consumers go through substantial elaboration in the process of attitude expression for their most daily food decisions.

7.2.3 Final conclusions

There is an emerging stream of research into understanding the underlying processes by which affective and cognitive bases of attitude are integrated in an overall attitude (Van Overwalle and Siebler, 2005, Schulte-Mecklenbeck et al., 2011). More specifically, besides the traditional bi-dimensional affective–cognitive bases of attitudes, some authors have proposed models for finer investigation into the dimensionality of each attitude base (Dubé et al., 2003). Giner-Sorolla (2001), argued for a distinction of attributes intrinsic to affective attitudes, reflecting their immediate or deliberate nature. In a similar vein, Dubé et al. (2003), stated that "*reducing attitudes to their affective and cognitive bases entails a significant loss of information tied to the immediate vs. deliberative nature of attributes that are nested within each basis, and that this precludes a full account of consumer's attitudinal judgments and behaviour*". The authors proposed a hierarchical model for capturing consumer attitudes to food, where attitude affective basis clusters immediate sensations such as taste, and deliberative emotions like guilt, whereas cognitive basis clusters immediate attributes such as convenience with consumption experience and deliberate attributes such as long term health consequences. Finucane et al. (2003), when discussing how affect influences judgment and decision making, note that "*The conditions under which affect operates as a deliberative or non-deliberative process in judgment and decision making raise questions for investigation".*

Moreover, researchers who did work on intuitive attitudes acknowledge the need for further scrutinising of underlying attitude bases. Trendel and Werle (2015), recently advocated for a distinction between the affective and cognitive bases of implicit[16] attitudes and proposed that "*the affective and cognitive bases of implicit attitudes towards a food item are distinct constructs that independently build the conventional overall implicit attitude towards the item*". Amodio and Mendoza (2010), conceptualised implicit evaluations in a similar way and argued that "*an implicit evaluation (i.e., attitude) may reflect a combination of affective and semantic (i.e., cognitive) associations*".

[16] In chapter 4, was discussed that different theorists and researchers have expressed different preferences for different terms when examining intuitive attitudes, such as "implicit", "unconscious" and "automatic".

In order to address this research call for investigating both attitude bases and processes underlying attitude formation, this study sought to shed light on both affective-cognitive bases of attitudes and intuitive-deliberate evaluations towards food products containing protein extracted from beef offal. Reflecting on the results in relation to these two main research issues, this study showed that participants relied more on deliberate process to form their overall attitudes, which were more affective in nature. It is possible, that in this case affect had to do more with elaborate forms of affect such as feelings and anticipated emotions with regard to the food products rather than immediate affect such as "gut" feelings. It should be noted that participants were informed that the taste of the burgers and sausages containing protein extracted from beef offal was the same to the taste of products without the inclusion of extracted protein. That was communicated intentionally, as this study did not intend investigating any taste expectations about food products containing beef offal derived protein or the influence of expected taste on participants' attitudes. That might have reduced any immediate affective inferences associated with palatability and hedonic reactions. However, this study cannot make any firm conclusions regarding the interaction of attitude bases and underlying processes, since they cannot be analysed together in the same model.

Besides the central hypotheses, this study considered the influence of socio-psycho-demographic factors on overall attitudes towards food products containing protein extracted from beef offal. A first explanatory analysis showed that participants' age and gender were found to have a significant effect on their attitudes. Specifically, males and younger participants expressed more positive attitudes towards food products containing protein extracted from beef offal. These results draw some parallels with research on consumer acceptance of novel foods and new food processing technologies. For example, females and older consumers have been found to express weaker readiness to adopt insects in their food routines (Verbeke, 2015), and greater concern about novel food processing technologies (Cardello, 2003). However, in the current study, when controlling for important study factors (i.e. attitude components, familiarity and information provision), socio-demographic showed no effect on participants' overall attitudes. This is not surprising, as the explanatory power of demographic variables alone is usually not very effective in explaining consumer behaviours (Wansink and Park, 2000, Dagevos, 2005).

An important concept that has been introduced to explain individual differences in accepting unfamiliar and novel foods is food neophobia (Pliner and Hobden, 1992, Bäckström et al., 2004), with many studies reporting a negative effect of food neophobia on acceptance ratings (e.g. Hoek et al., 2011, Arvola et al., 1999, Tuorila et al., 1994, Siegrist et al., 2013, Schickenberg et al., 2008). However, Siegrist et al. (2013) claimed that food neophobia is not a significant predictor of new products in general. For instance, food neophobia was not found to be a significant predictor of people's willingness to try genetically modified foods or organic food (Bäckström et al., 2004). In the current study no effect of neophobia on consumers' attitudes towards food products containing protein extracted from beef offal was found. An explanation for this could be the high level of participants' familiarity with the carrier products (i.e. burger and sausage). Participants were presented with visual stimuli of burgers and sausages which resemble the products they are used. Therefore, it could be the case that any potential food neophobia towards these product concepts was balanced by participants' high familiarity with the carrier products.

Participants with high levels of environmental concerns expressed more positive attitudes towards food products containing protein extracted from beef offal. This suggests that targeting consumers who value environmental protection through their food choices, could be a relevant market for products containing protein extracted from beef offal.

Finally, a point that should be stressed in order to ensure clarity of the results, concerns the nature of the attitude objects used in the current study. As mentioned earlier, hedonic aspects of food products have an important influence on consumers' food choices, while habitual shopping is also highly influential in guiding everyday food decisions (Grunert et al., 2010). The distinguishing characteristic of the food products under investigation in this study is that they involve ingredients that have been extracted from co-processing streams. These novel ingredients and even the technologies used to extract them and incorporate them into food products potentially place consumers' attitudes and decisions towards these products at another level, distant to habitual consumption practices and strictly hedonic associations. de Liver et al. (2005) when investigated attitudes towards GM food, proposed that attitudes towards GM food is best described in terms of separate

positive and negative affective and positive and negative cognitive components. The authors reported independence of aforementioned components and interpreted the results within the literature of attitudinal ambivalence, explaining that people can have positive and negative cognition and positive and negative affect (feelings) towards GM foods at the same time. The authors illustrated these results with an example: "*People may find GM food useful for production enlargement in the third world, whereas at the same time they may find it useless in daily life*" (de Liver et al., 2005, p.247). Therefore, while consumers are majorly interested in the hedonic characteristics of food, in cases where food products are perceived as contentious further complex considerations arise. In the present study, the nature of the food products is so that consumers' evaluation will extend beyond hedonic orientation to personal, societal and environmental influences.

7.3 Research limitations and recommendations for further research

As with any research, the scope of the present study is necessarily restricted. Although the endeavour was to maximise the contribution of this work, in line with best practice within consumer research there are some limitations that need to be considered.

A first limitation concerns the choice of product carriers and the use of merely one product category i.e. processed meats. Although this criticism applies to most consumer research work, it is important to state. This work used burgers and sausages as the carrier products. This choice was made on the grounds that there is a conceptual compatibility between protein extracted from beef offal and processed meats. Literature has shown that novel animal foods result in overall lower acceptance than novel non animal foods (e.g. grain products, fruits and vegetables) (e.g. Pliner and Pelchat, 1991, Martins et al., 1997). Thus it is possible that a different selection of product carriers may result in different responses. When the idea of food products that incorporate ingredients extracted from offal was introduced in focus groups in Ireland, consumers referred to cooking cubes, stir-in pasta and spice racks as possible acceptable carriers (Henchion et al., 2016). Future

research should further identify which other food products could be appropriate carriers.

The conceptualisation of familiar and unfamiliar product concepts warrants further research. Although the carrier products, i.e. burgers and sausages are well established food products, familiarity with the product concepts was addressed through the incorporation of one more familiar (i.e. beef liver) and one more unfamiliar (i.e. beef lung) protein source into the product carriers. Familiarity with the product concepts was measured in a pre-test with 33 participants, where burgers and sausages with protein extracted from beef lung scored lower in familiarity than burgers and sausages with protein extracted from beef. However, it is not clear if these scores reflect perceived familiarity with the ingredients (i.e. extracted protein from beef offal) or with the product concepts (i.e. carriers containing protein extracted protein beef offal). Future research should further identify what other product carrier- ingredient combinations are truly familiar or unfamiliar. Comparing attitudes toward unfamiliar food products from other cultures against familiar food products from one's own culture could be an interesting direction.

A further limitation has to do with the experimental set-up used in this study to investigate consumers' attitudes. While a questionnaire-based survey is the most common method, thanks to its relatively low cost and ease of administration, this method suffers from some limitations. The most salient of these are self-representation biases (e.g. responding in a way that reflects social desirability) and inability to report actual cognitive contents and behaviours (Glöckner and Herbold, 2011, Greenwald and Banaji, 2010). Moreover, limitations arise for the measures used to depict intuitive evaluations such as the Affective Misattribution Procedure used in this study. No intuitive measurement is process-pure, as they are all based on a behavioural task which involves a controlled process (e.g. press a button, make a choice) besides the automatic (Conrey et al., 2005). Physiological measurements such as Galvanic skin response, Heart rate variability, fMRI (a technique that measures brain activity by detecting changes associated with blood flow) and Eye-tracking provide insights into underlying psychological processes, without constraining any of the involved processes (Glöckner and Witteman, 2010). While it is practically impossible to apply these tools to a large study sample, it would be

interesting to combine these experimental studies with large representative sample surveys in order to acquire a deeper understanding on the underlying processes in attitude formation towards food products under investigation.

An inherent limitation in this study is that the product concepts presented to participants were fictitious. Reported evaluations might not entirely reflect participants' actual reactions and evaluations if the products were physically presented to them in a real situation (Grunert et al., 2011). Attitude–behaviour relationship is a long standing issue, explored by many authors and investigated through different models. Empirical evidence has shown that the attitude-behaviour inconsistency contradicts the idea that individuals' specific behaviours can be predicted from their attitudes (Ajzen and Cote, 2011, Smith and Hogg, 2008), since although attitude and behaviour are strongly related, "*they are not directly correspondent*" (Spence and Townsend, 2006, p. 658). Inconsistencies between individuals' perceptions of how they would act and how they actually act within a specific situation or towards an attitude object have been reported in different domains, as for instance towards organic foods (Aschemann-Witzel and Niebuhr Aagaard, 2014), racial attitudes and discriminatory behaviour (Ajzen and Cote, 2011), adoption of innovation (Arts et al., 2011), smoking, political behaviour and others (see Greenwald et al. (2009) for a meta-analysis of the literature on productivity of attitudes on specific behaviours). However, in spite of the potential attitude-behaviour inconsistency, this should not degrade the value of exploring consumers' attitudes towards the hypothetical food products containing protein extracted from beef, since the acquired results provided an understanding of the issues that could potentially influence consumers when forming their attitudes and processing information.

Finally, this quantitative research was intended to be representative of the adult Irish population. Research on consumers' attitudes from outside of Ireland could have resulted in different outcomes. It has been argued that findings of one country should not be generalized to other countries (de Barcellos et al., 2009, Meiselman et al., 2010). Rozin et al. (1999), when conducting a cross-cultural study of food attitudes pointed to culture as being an additional moderator of the relative dominance of

affective and cognitive basis of attitude. It could be possible that the current findings apply to other countries but subsequent research should be conducted to confirm this.

7.4 Industry recommendations

The current research demonstrated that participants in the study expressed relatively positive attitudes towards the food products containing protein extracted from beef, indicating that protein extracted from beef offal has a realistic potential to be incorporated into food products and to be accepted by consumers in Ireland. Specifically, familiar product concepts containing protein extracted from beef were more (deliberately) positively evaluated, than unfamiliar product concepts. Therefore, product developers should focus on incorporating protein extracted from familiar beef offal sources, such as liver or heart rather than more unfamiliar such as lung.

Accessibility and availability are key determinants of new food product success. Rozin (2006), suggests that it is innate in humans to favour foods that are easily obtained and that restrictions on either accessibility or availability can limit food choice. Moreover, historical evidence suggests that demand for new foods is often supply driven (Ellis et al., 2015). Limited supply and poor distribution channels can lead to failure, as has been recently observed with the disappearance of insect foods from selected Dutch supermarkets (House, 2016). Therefore, as with speciality and new foods, success with food products containing protein extracted from beef will be determined by mainstream availability.

Expectations in terms of taste also need to be met by developers. Sensory properties are critical factors in consumer evaluation of food products, with sensory research repeatedly finding poor taste to have a negative impact on acceptance (Schouteten et al., 2016). Researchers in the area of consumer acceptance of insects as food have highlighted that taste is of substantial importance in determining whether insect based foods are accepted or not and therefore taste should be a key focus of product development (Hartmann et al., 2015, Schouteten et al., 2016, Tan et al., 2015, Deroy et al., 2015). Hartmann et al. (2015), for instance, noted that the sensory properties of

insect foods are likely to be more influential than perceived nutritional benefits. House (2016) also noted that a lack of tasty and fitting context, in conjunction with limited supply, were key reasons that led to failure of insect foods in Dutch supermarkets. Therefore, when aiming for repeat consumption as opposed to merely trial, sensory properties of food products containing beef offal extracted protein should not be neglected.

Consumers' attitudes and acceptance of food products containing protein extracted from beef should be also considered at societal level. Public acceptance of many new foods (e.g. sushi, avocado) appears to be an evolutionary rather than a revolutionary process. Studies on foods that have initially been perceived as novel and have gradually gained widespread acceptance, show that new food first gain popularity in one small social segment before diffusing further (House, 2016). Following from work on the establishment of other new foods, it should be the early adopters, rather than general populations, receiving greater attention. Therefore, acceptance of food products containing protein extracted from beef could be constructed and negotiated, as time is an important factor in determining consumer acceptance. In this process, the meat industry should expect that consumers need to be familiar with these new food products over time and be prepared to respond to consumers' concerns. In this context, it should be noted that besides the meat industry and product developers, government agencies and regulatory bodies need to be involved. These bodies need to provide reassurance on proper labelling of the products containing protein extracted from beef and clarity on safety and potential techno-functional, health and environmental benefits of these products. For example, the use of informative quality marks (such as Bord Bia quality assured), origin labels (produced in Ireland) and nutritional information on the packaging might reduce any potential consumers' concerns regarding the quality, the safety and ethical and environmental concern associated with these products.

In addition to carefully designing products containing protein extracted from beef and availability of these products, targeted marketing strategies should be also considered as a precondition for their success. Promotion of these products through social media and cooking shows that providing information and allowing social interaction over phone, emails, and other communication platforms that

contemporary customers crave could be promising strategies. Communication of new things is often cognitive in nature, with a focus on explaining (Dudo, 2013). Indeed, the current study showed that providing information about the health and environmental benefits of consuming food products containing protein extracted from beef was (deliberately) positively evaluated. Therefore, any action that would favour deliberation, such as informative leaflets might increase the possibility that deliberate attitudes would drive consumers' attitudes and potentially their choice in the market place. However, most importantly, the present research supports that it is also important to address people's affect when communicating information about these food products. Therefore, communication of products containing protein extracted from beef should be carefully designed to accommodate both affective and cognitive information.

Finally, it should be realised that in order to achieve successful inclusion of protein extracted from beef in humans' diet, collective action of all stakeholders (e.g. public bodies, food industry, policy makers, universities and research institutions) is necessary. While marketing strategies at product level (i.e. around the food product containing protein extracted from beef) is essential, broader communication which targets consumer acceptance of products containing ingredients that have been extracted from co-processing streams more generally is equally essential. This communication could be embedded in the context of the circular economy and the aim of transitioning towards a more sustainable society. Moreover, this interdisciplinary approach allows communication between different stakeholders supporting learning across organisations and sectors. In this way, industry awareness will be also achieved, with manufacturers having access to information regarding the opportunities to develop products containing ingredients from co-processing streams.

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Appendices

Appendix I: Protein extraction processing technologies

Acid/alkaline solubilisation (or commonly referred as pH shift) is a process based on the principle that the solubility of proteins contained in a material homogenized in water is affected by the pH of the mixture (Nolsøe and Undeland, 2009). The pH shift is carried out with the addition of food grade acids/alkali (e.g. citric acid, sodium carbonate). After this step, a centrifugation or filtration process takes place in order to separate the soluble proteins from the unwanted insoluble materials. In the next step, the proteins in solutions are precipitated, by modifying the pH of the mixture to the original value, and in this way the proteins become insoluble and are selectively precipitated. Such proteins can be easily recovered by conventional techniques such as filtration or centrifugation. The ISP of food proteins has been long applied to recover milk and soy proteins and by in depth understanding of muscle proteins behaviour and it is suggested that food industry would be able to develop this technology for the processing of muscle by-products at a commercial scale (Bhattacharjee et al., 2015).

Membrane processes, based on the use of molecular size selective membrane, result in a permeate containing all components that have permeated the membranes and a retentate containing the compounds retained by the membrane (Gerschenson et al., 2015). Membrane separation technologies are popular in industrial applications and largely used in dairy industry and in food processing wastewater (e.g. olive mill wastewaters) among other industries (Galanakis et al., 2010, Gerschenson et al., 2015).

Enzymatic hydrolysis of proteins is the technique mostly used in laboratories and industry for peptide generation (Ryan et al., 2011). The hydrolysis reaction is usually carried out for a few hours in reactors and offers predictability in respect to the end product (Mora et al., 2014).

Chromatography methods in general may be preparative aiming to separate specific components of a mixture for later use (i.e. purification) or analytical in order to detect or to measure the presence of a compound (Bertin et al., 2015). These methods are widely used in nutraceuticals where small compounds such as vitamins need to be obtained, and in food industry for food quality purposes. Chromatography methods following different principles (e.g. size exclusion, ion-exchange) are the most common ways used for the purification of bioactive peptides (Lafarga and Hayes, 2014). These techniques have the advantages of providing a pure product but they can be expensive, laboratory-intensive, and time and solvent consuming (Galanakis, 2012).

Appendix II: Questionnaire used on familiarity pre-test

Teagasc-UCC Food Ingredients Study

15th of November 2018

Welcome and thank you for taking the time to answer this questionnaire. This study is a part of a project about consumers' attitudes to products containing ingredients derived from beef offal. Beef offal (e.g. lung, heart, liver, blood, bone, skin) is high in protein content. This protein is extracted, isolated and incorporated in any food product.

In the following questions we ask you to give us information on how familiar you are with some food and food ingredients. The questionnaire will take less than 5 minutes to complete and there are no right or wrong answers. The results will be processed anonymously and your identity cannot be deduced.

Q.1 Are you? ____Male _____ Female

Q2. Please, indicate the year of your birthday _____

Q3. What is the highest level of education you have obtained?

- ☐ Primary education
- ☐ Secondary education
- ☐ University, up to degree level
- ☐ University, Masters or Doctorate

Q4. Please indicate how familiar you are with the following food ingredients. Please tick the most appropriate box for every ingredient.

	Not known as food	Known as food but never tasted	Tasted before	Eat occasionally	Eat regularly
protein derived from beef **lung**					
protein derived from beef **heart**					
protein derived from beef **liver**					
protein derived from beef **blood**					
protein derived from beef **bone**					
protein derived from beef **skin**					

Q5. Please indicate how familiar you are with the following food products. Please tick the most appropriate box for every ingredient.

Burger with added protein derived from…	Not known as food	Known as food but never tasted	Tasted before	Eat occasionally	Eat regularly
beef **lung**					
beef **heart**					
beef **liver**					
beef **blood**					
beef **bone**					
beef **skin**					

Sausage with added protein derived from…	Not known as food	Known as food but never tasted	Tasted before	Eat occasionally	Eat regularly
beef **lung**					
beef **heart**					
beef **liver**					
beef **blood**					
beef **bone**					
beef **skin**					

Protein bar with added protein derived from…	Not known as food	Known as food but never tasted	Tasted before	Eat occasionally	Eat regularly
beef **lung**					
beef **heart**					
beef **liver**					
beef **blood**					
beef **bone**					
beef **skin**					

Beef jerky with added protein derived from…	Not known as food	Known as food but never tasted	Tasted before	Eat occasionally	Eat regularly
beef **lung**					
beef **heart**					

beef **liver**					
beef **blood**					
beef **bone**					
beef **skin**					

Appendix III: Questionnaire used on information provision pre-test

a) Benefit Information

Teagasc-UCC Food Ingredients Study

November 2018

Thank you for taking the time to answer this questionnaire. This study is a part of a project about consumers' attitudes to products containing offal derived ingredients. In the following, you will read some information on offal derived protein and you will be asked to give your opinion on some aspects of this information.

The questionnaire will take less than 5 minutes to complete and there is no right or wrong answers. The results will be processed anonymously and your identity cannot be deduced.

Q1. Are you? ____Male _____ Female

Q2. Please, indicate the year of your birthday _____

Q3. What is the highest level of education you have obtained?

- ☐ Primary education
- ☐ Secondary education
- ☐ University, up to degree level
- ☐ University, Masters or Doctorate

Below you see a burger with added protein derived from beef offal.

You will now read some information regarding protein derived from beef offal used for this burger's preparation and you will be asked to give your answers in some questions regarding this information.

Information box

Protein derived from beef offal is an important source of protein for humans. Eating enough protein is important for good health. Protein derived from beef offal is high-quality protein, in terms of health value and can be absorbed easily by human body.

In addition, products that use protein derived from beef offal are environmentally friendly, because existing beef sources are used for its production and no additional beef farming is required, i.e. existing beef sources can be used more efficiently. Protein derived from beef offal can make a significant contribution to worldwide protein demand and mitigate the environmental impact of existing food supply chain operations.

Q4. Please describe your views about the statements presented in the above information.

In your opinion, the information arguments made above were:

very weak	1	2	3	4	5	6	7	**very strong**
not very convincing	1	2	3	4	5	6	7	**very convincing**
not very powerful	1	2	3	4	5	6	7	**very powerful**
very negative	1	2	3	4	5	6	7	**very positive**

b) Ambiguous Information

Teagasc-UCC Food Ingredients Study

November 2018

Thank you for taking the time to answer this questionnaire. This study is a part of a project about consumers' attitudes to food products containing offal derived ingredients. In the following, you will read some information on offal derived protein and you will be asked to give your opinion on some aspects of this information.

The questionnaire will take less than 5 minutes to complete and there are no right or wrong answers. The results will be processed anonymously and your identity cannot be deduced.

Q1. Are you? ____Male _____ Female

Q2. Please, indicate the year of your birthday _____

Q3. What is the highest level of education you have obtained?

- ☐ Primary education
- ☐ Secondary education
- ☐ University, up to degree level
- ☐ University, Masters or Doctorate

Below you see a burger with added protein derived from beef offal.

You will now read some information regarding protein derived from beef offal used for this burger's preparation and you will be asked to give your answers in some questions regarding this information.

Information box

Protein derived from beef offal could be an important source of protein for humans if treated and processed correctly. Eating enough protein is important for good health. Protein derived from beef offal is high-quality protein, in terms of health value, however if improperly treated, protein derived from beef offal does not supply any health benefits to humans.

In addition, under certain circumstances, products that use protein derived from beef offal could be environmentally friendly, as existing beef sources are used for its production and no additional beef farming is required, i.e. existing beef sources would be used more efficiently. However, there is a need to improve the way the protein is produced from such sources, particularly in terms of energy used, in order to avoid a negative environmental impact.

Q4. Please describe your views about the statements presented in the above information.

In your opinion, the information arguments made above were:

very weak	1	2	3	4	5	6	7	**very strong**
not very convincing	1	2	3	4	5	6	7	**very convincing**

not very powerful	1	2	3	4	5	6	7	**very powerful**
very negative	1	2	3	4	5	6	7	**very positive**

Appendix IV: Questionnaire used on consumer survey

Teagasc-UCC
Attitudes to food products containing protein extracted from different sources

"Information and consent form"

Welcome

Thank you for taking the time to answer this survey about food and protein. This survey is conducted by researchers based at Teagasc and University College Cork, who are interested in consumers' attitudes and opinions to food products containing protein derived from different sources. The study will ask for your opinion, attitudes and beliefs in relation to food and life generally. The questionnaire takes approximately 10-15 minutes to complete.

Participation in this survey is completely voluntary. You have the opportunity to withdraw from the survey at any stage. Respondents are anonymised in the data collected, and therefore no identifiable references will be made to you in the data collected or in reports and publications. Data will be aggregated and therefore respondents cannot be connected to specific statements from the survey procedure. The survey data will be kept securely, available only to the researchers.

I have read the information about the survey and consent, and I agree to participate in this research study:

For all questions that are asked, we are interested in your opinion. There are therefore no right or wrong answers. Participation in this questionnaire is voluntary.

D1. Are you? ____Male _____ Female

D2. What is your age? (Please enter the age below)

_ _ <numeric min 0, max99>

D3. What County do you live in? (pulldown)

List 26 ROI counties

D4. What is your current employment status?

If more than one option is applicable, e.g. you are employed part-time and a student, please select the activity that takes up the most of your time.

1. Working full time (35 or more hours per week)
2. Working part-time (less than 35 hours per week)
3. Self-employed
4. Unemployed and looking for work
5. Looking after my home/family full time
6. Student
7. Retired
8. Unable to work
9. Other, please specify:

D5. What is your highest level of education?

1. Primary school
2. Secondary school
3. Third level (non-degree i.e. Diploma, Certificate)
4. Third level (degree or higher i.e. Undergraduate, Postgraduate, PHD etc.)

D6. Please indicate to which occupational group the chief income earner in your household belongs, or which group fits best.

The chief income earner is the person in your household with the largest income; this could be yourself or another person in your household.

1. Higher managerial/ professional/ administrative (e.g. doctor, solicitor, board director)
2. Intermediate managerial/ professional/ administrative (e.g. board director small organisation, middle manager, principle officer in civil service)
3. Supervisory or clerical/ junior managerial/ professional/ administrative (e.g. office worker, salesperson)
4. Student
5. Skilled manual worker (e.g. Carpenter, Plumber, Painter, Bus Driver, Pub/Bar worker)
6. Semi or unskilled manual work (e.g. Manual worker, Caretaker, Park Keeper, Shop Assistant)
7. Casual worker – not in permanent employment
8. Home-maker
9. Retired

10. Farmer 1-49 acres
11. Farmer 50+ acres
12. Unemployed or not working due to long-term sickness

S1. Please indicate how often, on average, you have eaten each food during the past year. Please tick one box per row.

	Daily	5-6 times per week	2-4 times per week	Once a week	1-3 times per month	Less than once per month	Never
Breakfast cereals							
Yogurt							
Burger							
Cheese							
Sausage							
Protein bars							
Cookies/Biscuits							
Beef							

Close if code "Never" for burger and sausage

S2. Have you been living in Ireland for the past 3 consecutive years?

Yes
No-thank and close

S3. Do you work (or have you previously worked) in the area of food product development, food technology or market research?

Yes-thank and close
No

S4. Do you speak or read any of the following languages (even at basic level)?

French

German
Chinese languages

Yes Chinese -thank and close
No

Q. Do you have any food allergies, intolerance, special dietary requirements?

Yes
No

Thank you for your time and participation. Unfortunately it would appear that you do not fit the exact profile required for this survey.

Part 1

In this section you will see three sets of images with each set containing two images. The first image is of a food product containing protein extracted from a certain source.

Please ignore the first image and answer the question that follows in relation to the second image.

Please click Continue to progress.

Q. I find this sign...

- ☐ Very unpleasant
- ☐ Unpleasant
- ☐ A little unpleasant
- ☐ Not unpleasant / not pleasant
- ☐ A little pleasant
- ☐ Pleasant
- ☐ Very pleasant
- ☐ Image not seen

Please click Continue to progress.

Q. I find this sign...

- ☐ Very unpleasant
- ☐ Unpleasant
- ☐ A little unpleasant
- ☐ Not unpleasant / not pleasant
- ☐ A little pleasant
- ☐ Pleasant
- ☐ Very pleasant
- ☐ Image not seen

Please click Continue to progress.

Part 2

You will now see the images of the food products that contain added protein extracted from beef liver for a longer period. Protein extracted from beef liver can be incorporated into any food product without altering how it looks, tastes or smells.

Please click Continue to progress.

Please review the product below:

This burger contains protein extracted from beef liver. Protein extracted from beef liver is good for health and good for the environment. However, when improperly treated, protein extracted from beef liver does not give any health benefits and can have a negative environmental impact.

Protein extracted from beef liver could be an important source of protein for humans if treated and processed correctly. Eating enough protein is important for good health. Protein extracted from beef liver is high-quality protein, in terms of health value, however if improperly treated, protein extracted from beef liver does not supply any health benefits to humans.

In addition, under certain circumstances, products that use protein extracted from beef liver could be environmentally friendly, as existing beef sources are used for its production and no additional beef farming is required, i.e. existing beef sources would be used more efficiently. However, there is a need to improve the way the protein is produced from beef liver, particularly in terms of energy used, in order to avoid a negative environmental impact

Q. For each of the options below, please tick the box that best represents your opinion about this burger.

My overall opinion about this burger with added protein extracted from beef liver is….

Please select one option for each row

favourable	□	□	□	□	□	□	□	**unfavourable**
likeable	□	□	□	□	□	□	□	dislikeable
good	□	□	□	□	□	□	□	bad

Q. For each of the options below, please tick the box that best represents your feelings about this burger.

This burger with added protein extracted from beef liver makes me feel….

Please select one option for each row

happy	□	□	□	□	□	□	□	**sad**
totally conflicted	□	□	□	□	□	□	□	not conflicted at all
bored	□	□	□	□	□	□	□	excited
pleasant	□	□	□	□	□	□	□	unpleasant
totally indecisive	□	□	□	□	□	□	□	not at all indecisive
concerned	□	□	□	□	□	□	□	unconcerned
a completely mixed reaction	□	□	□	□	□	□	□	a completely one sided reaction
disgusted	□	□	□	□	□	□	□	delighted

Q. For each of the options below, please tick the box that best represents your beliefs about this burger.

I believe eating this burger with added protein extracted from beef liver would be…..

Please select one option for each row

healthy	□	□	□	□	□	□	□	**unhealthy**
unsafe	□	□	□	□	□	□	□	safe
not tasty	□	□	□	□	□	□	□	tasty
unnatural	□	□	□	□	□	□	□	natural

Q. For each of the options below, please tick the box that best represents your beliefs about this burger.

I believe producing this burger with added protein extracted from beef liver would be…..

Please select one option for each row

beneficial	□	□	□	□	□	□	□	**harmful**
unnecessary	□	□	□	□	□	□	□	necessary
positive	□	□	□	□	□	□	□	negative
meaningless	□	□	□	□	□	□	□	meaningful

Q. How acceptable do you think this burger with added protein extracted from beef liver is?

Extremely acceptable	□	□	□	□	□	□	□	**Extremely unacceptable**

Q. Imagine that there is a free tasting session in your usual butcher shop/ supermarket, how willing would you be to taste this burger with added protein extracted from beef liver?

Extremely unwilling	□	□	□	□	□	□	□	**Extremely willing**

Q. Imagine that you are doing your grocery shopping and this burger with added protein extracted from beef liver is available. Would you be willing to buy it?

Extremely unwilling	□	□	□	□	□	□	□	**Extremely willing**

Please click Continue to give your opinion about these sausages.

These sausages contain protein extracted from beef liver. Protein extracted from beef liver is good for health and good for the environment. However, when improperly treated, protein extracted from beef liver does not give any health benefits and can have a negative environmental impact

Protein extracted from beef liver could be an important source of protein for humans if treated and processed correctly. Eating enough protein is important for good health. Protein extracted from beef liver is high-quality protein, in terms of health value, however if improperly treated, protein extracted from beef liver does not supply any health benefits to humans.

In addition, under certain circumstances, products that use protein extracted from beef liver could be environmentally friendly, as existing beef sources are used for its production and no additional beef farming is required, i.e. existing beef sources would be used more efficiently. However, there is a need to improve the way the protein is produced from beef liver, particularly in terms of energy used, in order to avoid a negative environmental impact.

Please click Continue to give your opinion about these sausages on the following questions.

Q. For each of the options below, please tick the box that best represents your opinion about these sausages.

My overall opinion about these sausages with added protein extracted from beef liver is….

Please select one option for each row

favourable	□	□	□	□	□	□	□	**unfavourable**
likeable	□	□	□	□	□	□	□	dislikeable
good	□	□	□	□	□	□	□	bad

Q. For each of the options below, please tick the box that best represents your feelings about these sausages.

These sausages with added protein extracted from beef liver make me feel….

Please select one option for each row

happy	□	□	□	□	□	□	□	**sad**
totally conflicted	□	□	□	□	□	□	□	not conflicted at all
bored	□	□	□	□	□	□	□	excited
pleasant	□	□	□	□	□	□	□	unpleasant
totally indecisive	□	□	□	□	□	□	□	not at all indecisive
concerned	□	□	□	□	□	□	□	unconcerned

a completely mixed reaction	□	□	□	□	□	□	□	a completely one sided reaction
disgusted	□	□	□	□	□	□	□	delighted

Q. For each of the options below, please tick the box that best represents your beliefs about these sausages.

I believe eating these sausages with added protein extracted from beef liver would be…..

Please select one option for each row

healthy	□	□	□	□	□	□	□	**unhealthy**
unsafe	□	□	□	□	□	□	□	safe
not tasty	□	□	□	□	□	□	□	tasty
unnatural	□	□	□	□	□	□	□	natural

Q. For each of the options below, please tick the box that best represents your beliefs about these sausages.

I believe producing these sausages with added protein extracted from beef liver would be…..

Please select one option for each row

beneficial	□	□	□	□	□	□	□	**harmful**
unnecessary	□	□	□	□	□	□	□	necessary
positive	□	□	□	□	□	□	□	negative
meaningless	□	□	□	□	□	□	□	meaningful

Q. How acceptable do you think these sausages with added protein extracted from beef liver are?

Extremely acceptable	□	□	□	□	□	□	□	**Extremely unacceptable**

Q. Imagine that there is a free tasting session in your usual butcher shop/ supermarket, how willing would you be to taste these sausages with added protein extracted from beef liver?

Extremely unwilling	□	□	□	□	□	□	□	**Extremely willing**

Q. Imagine that you are doing your grocery shopping and these sausages with added protein extracted from beef liver are available. Would you be willing to buy them?

Extremely unwilling	□	□	□	□	□	□	□	**Extremely willing**

Part 3

Q. Please indicate your level of agreement with the following statements.

	Strongly disagree	**Slightly disagree**	**disagree**	**Neither agree or disagree**	**Slightly agree**	**agree**	**Strongly agree**
I am very particular about the healthiness of food I eat							
It is important to me that my diet is low in fat							
It is important to me that the food I eat on a typical day is good value for money							
I am very particular about the foods I eat							
It is important to me that the food I eat on a typical day has been prepared in an environmentally friendly way							
I am afraid to eat things I have never had before							

I always follow a healthy and balanced diet							
It is important to me that my daily diet contains a lot of vitamins and minerals							
I like foods from different cultures							
It is important to me that the food I eat on a typical day has been produced in a way which has not shaken the balance of nature							
The healthiness of food has little impact on my food choices							
I eat what I like and I do not worry much about the healthiness of food							
I do not avoid foods, even if they if they may raise the risk of certain health problems							
It is important to me that the food I eat on a typical day can be cooked very simply							
I am constantly sampling new and different foods							
It is important to me that the food I eat on a typical day is not expensive							
It is important to me that the food I eat on a typical day has been prepared in an environmentally friendly way							
I like to try new ethnic restaurants							
It is important to me that the food I eat on a typical day is easily available is shops and supermarkets							

The healthiness of snacks makes no difference to me							
At dinner parties, I will try new foods							
It is important to me that the food I eat on a typical day is cheap							
It is important to me that the food I eat on a typical day is easy to prepare							
I don't trust new foods							
If I don't know what a food is, I won't try it							
It is important to me that the food I eat on a typical day can be bought in shops close to where I work or live							
Ethnic food looks too weird to eat							

Part 4

Q. Please indicate the position that best describes your opinion

I am positive about eating ……	Disagree strongly	Disagree	More or less disagree	Undecided	More or less agree	Agree	Strongly agree
Burgers in general							
Sausages in general							

Q. Please evaluate the following sign

□ Very unpleasant
□ Unpleasant
□ A little unpleasant
□ Not unpleasant / not pleasant
□ A little pleasant
□ Pleasant
□ Very pleasant
□ Image not seen

□ Very unpleasant
□ Unpleasant
□ A little unpleasant
□ Not unpleasant / not pleasant
□ A little pleasant
□ Pleasant
□ Very pleasant
□ Image not seen

Thank and Close